What about causality? Examining longitudinal relations between work characteristics and mental health

de Lange, A.H.

2005

What about causality?
Examining longitudinal relations between work characteristics and mental health

Annet de Lange

What about causality? Examining longitudinal relations between work characteristics and mental health/ Annet de Lange

Most of the studies presented in this thesis were part of the Study on Musculoskeletal disorders, Absenteeism, Stress and Health (SMASH). SMASH was collected by TNO Work and Employment (the Netherlands), and financially supported by the Dutch Ministry of Social Affairs and Employment, the Dutch Ministry of Public Health, Welfare and Sports, and the Dutch National Institute for Social Security.

ISBN: 90-76-26-94-24

Cover design: Leonard van Munster (info@donleo.org)
Printing: Offsetdrukkerij Ridderpint B.V., Ridderkerk (the Netherlands)

Webdoc Library Radboud University Nijmegen (http://www.ru.nl/ubn):
http://webdoc.ubn.ru.nl/mono/l/lange_a/whatabca.pdf

What about causality?
Examining longitudinal relations between work characteristics and mental health

Een wetenschappelijke proeve op het gebied van de Sociale Wetenschappen

PROEFSCHRIFT

Ter verkrijging van de graad van doctor
aan de Radboud Universiteit Nijmegen,
op gezag van de Rector Magnificus prof. dr. C.W.P.M. Blom,
volgens besluit van het College van Decanen
in het openbaar te verdedigen op donderdag 31 Maart 2005
des namiddags om 3:30 uur precies
door

Antoinette Harmke (Annet) de Lange

Geboren op 2 april 1977 te Zwolle

Promotor:	Prof. dr. M.A.J. Kompier
Co-promotoren:	Dr. T.W. Taris
	Dr. I.L.D. Houtman (TNO Arbeid)
	Prof. dr. P. M. Bongers (TNO Arbeid; Body@work.nl TNO-VU)
Beoordelingscommissie:	Prof. dr. A.F.M. van Knippenberg
	Prof. dr. W.B. Schaufeli (Universiteit Utrecht)
	Prof. dr. J.M.A. Riksen-Walraven

“Onderzoek alles en behoudt het goede!”

“Explore everything and keep the good!”

Hilde de Lange-Straatsma

Table of Contents

Acknowledgements

This page is one of the most important pages of this book as it provides the names of the people that inspired, coached, or entertained me during the past years of writing this thesis. When I started this project I thought that writing the acknowledgements would be an easy task, but I now realize that it may be impossible to thank everyone that had an influence on my work on one or two pages. I will therefore focus on a select number of people that have been of significant influence.

Let me start with thanking my promotor Michiel Kompier. Michiel knew how to inspire me to put all my efforts in this thesis. His secret strategy was to always start with a compliment about a draft before discussing the points of criticism. Furthermore, he gave me many opportunities to grow as a researcher. I will always be grateful for his supervision and support.

Toon Taris was my direct supervisor in Nijmegen. Toon is a true "science-aholic" and an expert on various research topics. He is a very approachable, down-to-earth type of supervisor who inspired and coached me in numerous ways. It was an honour to work with him.

Another important contribution to this thesis was given by Irene Houtman and Paulien Bongers. They not only provided a lot of relevant feedback on earlier drafts of this thesis and answered many questions about the SMASH data, but also stimulated me to go to conferences and to continue my PhD-work. I admire their expertise and research.

Furthermore, I owe my gratitude to Geertje Ariëns, Lisette Hoogendoorn and TNO work and employment for collecting the SMASH data (study on musculoskeletal disorders, absenteeism, stress and health; financially supported by the Dutch Ministry of Social Affairs and Employment; The Dutch Ministry of Public Health, Welfare, and Sports; and the Dutch National Institute for Social Security), and Jan de Jonge for writing the PhD-project that formed the basis for this study.

I would also like to thank my former colleagues of the department of Work and Organizational Psychology of the Radboud University of Nijmegen for the relevant discussions about research and for the social support they provided during my PhD-work,

especially, Josje Dikkers, Monique Willemsen, Monique van der Hulst, and Ingrid van der Wal deserve a big thank you.

I am also grateful to my current colleagues of the department of Management and Organisation of the Vrije Universiteit of Amsterdam (Paul Jansen, Lidewey van der Sluis, Claartje Vinkenburg, Donna Drivers-Zwartkruis, Nanja Schouten, Nienke Kimsma, Meindert Flikkema, Lisette Tepe etc.) for making it possible to finish this project, for stimulating my new research ideas and for being such pleasant people.

I would also like to thank Robert Karasek, Paul Landsbergis, Peter Schnall, Joe Schwartz, and other authors of the 45 longitudinal studies that responded to my review requests and provided valuable suggestions for improving the review included in this thesis.

Several friends have listened to my research stories and deserve a thank you for just listening, especially, Jetteke Loomans, Eva Demerouti, and Anneke den Hertog-van Atten were such nice friends. Furthermore, I would like to thank Leonard van Munster for designing the cover of this manuscript.

My family has always listened to my PhD-stories and gave me the support I needed. My mum followed me every day, my dad inspired me to follow my ambitions, and they both gave me valuable advice on various issues. My sister Femke is currently completing her own PhD-thesis and is, therefore, also my “sister in science”. Christiane and Aleida have always listened to me, checked my English, or provided nice distractions from work.

Joost has always been there for me to give the love and support I needed. There is nothing better than coming home to him.

Again, you all deserve a big thank you!

Annet

Utrecht, 1-12-2004

1

Introduction

1.1 Psychosocial work characteristics and mental health

During the past decades the workplace has changed dramatically due to factors like the globalization of the economy, continuous reorganizations, the use of new information and communication technologies, the growing diversity of our workforce (e.g., more women, older and highly educated employees) and an increased (mental) work load (Kompier, 2002; Landsbergis, 2003; NIOSH, 2002; Schabracq, 2003). During these years of occupational changes, workers also reported an increasing level of mental health problems. It has been estimated that 20% of the European working population experiences some type of mental health problem (Harnois & Gabriel, 2000). The most common psychological complaints of these workers are workrelated stress (28%) and overall fatigue (23%; Paoli & Merllié, 2001). Moreover, mental health problems constitute one of the three leading causes of work disability worldwide and have negative consequences for the individual as well as the companies they work for (Harnois & Gabriel, 2000; Schaufeli & Kompier, 2001). Examples of negative consequences are unhappy workers, loss of productive employees and associated costs. The Netherlands reports one of the highest percentages of work incapacitation due to mental health disorders (currently accounting for more than 38 % of the Dutch work incapacitation rates), of which the costs have been estimated at € 5 billion per year (Koningsveld et al., 2003; Andries, Houtman & Hupkens, 2004).

It is therefore not surprising that the workplace itself has become a health issue for employees, employers and their organisations (Schabracq et al., 2003). Different European countries have introduced legislation directed at improving the health and safety of workers in their work environments. The 'European Union Framework Directive' on health and safety at work (89/391/EEC: 1993) is one of the most prominent examples of these (Kompier, 2002). The Dutch government has also recognized these problems and developed the Dutch Working Conditions Act to regulate the workplace and to prevent work related (mental) health problems (Schaufeli & Kompier, 2001). Against the background of this growing problem, this thesis examines whether job characteristics may be regarded as causes of mental health problems or vice versa, and pays attention to important methodological and unresolved issues in examining this question.

In the literature mental health has been conceptualised in different ways. Some researchers use various dimensions to conceptualise mental health (like affective, cognitive or social dimensions; e.g. Le Blanc et al., 2000; Schaufeli & Bakker, 2001; Van Horn et al.,

2004), whereas other researchers conceptualise mental health as a state (indicative for positive or negative moods and feelings), a process (indicative of coping behaviour), or an outcome of a process (resulting from chronic exposure to intense confrontation with a stressor; Houtman & Kompier, 1998). To empirically measure job related mental health, Warr (1987, 1994) suggested three important affective dimensions, namely: 'displeasure - pleasure', 'anxiety - comfort' and 'depression - enthusiasm'. Recently, Van Horn et al. (2004) suggested that these affective dimensions can be seen as the most central dimensions of mental health. In this thesis, we will therefore study common indicators of affective well-being[1] (cf. Le Blanc et al., 2000, p. 162), namely depressive mood and emotional exhaustion (indicative for the dimension 'depression to enthusiasm'; cf. Van Horn et al., 2004), and job satisfaction (indicative for the dimension 'displeasure to pleasure'; cf. section 1.4). Further, we will examine whether these measures can be regarded as outcomes of the exposure to different work characteristics (e.g. Houtman & Kompier, 1998).

Many people consider work to be a major causal agent in explaining mental health. Recent European figures show that 60% of the workers reporting (mental) health problems believe that their work is the *cause* of these (compared to 57% in 1995; Paoli & Merllié, 2001). Employees often mention physical workload, mental workload and general working conditions as the major causes of their health complaints (Schaufeli & Kompier, 2001). Similarly, conceptual models in occupational health research assume that the *psychosocial* work environment (referring to psychological and social job conditions) can impinge upon the worker, *causing* varying affective and behavioural outcomes (Kompier, 2003; Spector, 1992). One influential example of these occupational health models is the Demand-Control model (hereafter DC model; Karasek, 1976, 1979; Karasek & Theorell, 1990). The DC model can be seen as a stimulus-response model (Taris & Kompier, 2004), in which two psychosocial work characteristics (stimuli) elicit the development of (mental) health, namely Psychological Demands (defined as psychological stressors present in the work environment) and Job Control (or Decision Latitude: indicating the amount of control the worker has over his tasks and behaviour on the job). According to the *strain* hypothesis of

[1] In this thesis 'psychological well-being' and 'mental health' are used synonymously.

the DC model, people working in high-strain jobs[2] (characterized by high job demands and low control) will develop strain-related outcomes[3] such as lack of psychological (or affective) and physical well-being, whereas people working in low-strain jobs (with low job demands and high control) will develop a lower-than-average level of strain-related outcomes. The particular combination of demands and control is also assumed to explain the development of motivation for learning. According to the *activation hypothesis* of the DC model, people working in active jobs (characterized by high job demands and high control) will develop high levels of intrinsic motivation for learning and personal growth, whereas people working in passive jobs (with low job demands and low control) will display low levels of these activation-related outcomes. According to the activation hypothesis, people working in low- and high-strain jobs will experience moderate levels of intrinsic motivation for learning and personal growth.

Inspired by the work of Johnson and Hall (1988), the Demand-Control model was expanded with a third dimension, *Social support*, (i.e., helpful social interaction available on the job from both co-workers and supervisors), resulting in the Demand-Control-Support model (DCS model; see Figure 1.1, Karasek & Theorell, 1990). According to the DCS model, strain-related health problems can be expected in a high-strain job with high job demands, low control and low social support (i.e., the "iso-strain" hypothesis), and activation-related outcomes can be expected in active jobs with high job demands, high control and high social support. This thesis only examines the strain hypothesis of the DC/S model, as we want to examine the causal nature of the relation between the DC/S dimensions and mental health. Elsewhere we deal with the activation hypothesis (Taris, Kompier, de Lange, Schaufeli & Schreurs, 2003).

---

[2] The labels "high strain" and "low strain" are misleading as they do not refer to the job content (particular combination of demands and control), but rather to the presumed outcomes of working in these jobs (Taris & Kompier, 2004).

[3] The terms "stress complaints" and "strain outcomes" are used synonymously in this thesis and refer to a range of employee's outcomes in terms of physical as well as mental health; as a response to a loss or lack of control over one's work performance (cf. Hurrell et al., 1998; Schabracq, 2003, p. 27). This thesis only focuses on indicators of mental health. However, chapter 2 and 4 also present some results that can be seen as indicators of physical health.

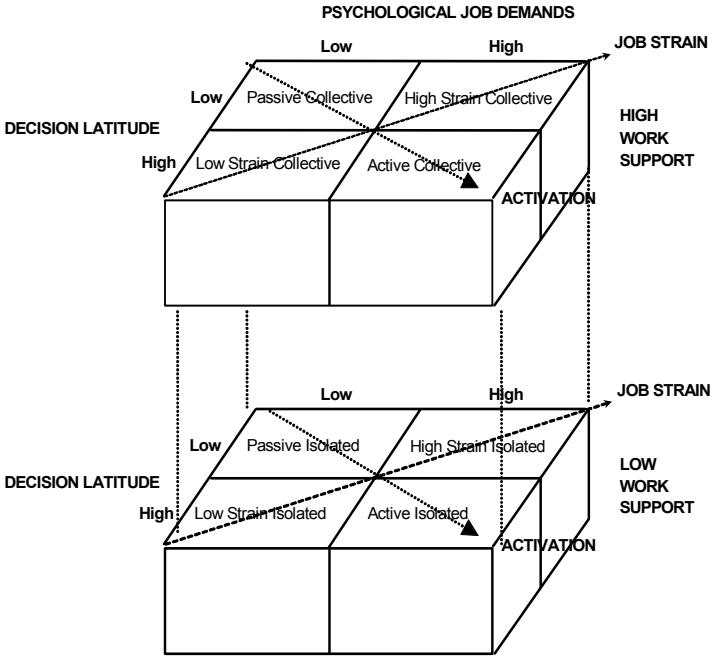


Figure 1.1

The Demand-Control-Support model (adapted from Johnson & Hall, 1988)

The Demand-Control-(Support) model is influential due to its simplicity, broad applicability, emphasis on structural characteristics of the work environment, and its focus on negative as well as positive effects of work (de Jonge & Kompier, 1997; Kompier, 2003). Especially the strain hypothesis of the Demand-Control-(Support; DC/S) model has been examined in numerous studies and comprehensive reviews have already been published (e.g., Belkić et al., 2004; van der Doef & Maes, 1998, 1999; Houtman et al., 1999; de Jonge & Kompier, 1997; Schnall et al., 1994; Schnall et al., 2000; Tennant, 2001). These reviews include epidemiological studies, quasi-experimental studies, studies based on homogeneous or heterogeneous populations, and intervention studies (de Jonge & Kompier, 1997; Schnall et al., 2000). These studies mostly provide evidence for separate main effects of the work characteristics (in line with the DC/S model; van der Doef & Maes, 1999; de Jonge & Kompier, 1997). The assumption that especially the statistical

interaction of high demands and low control (and, perhaps, low social support) yields adverse health outcomes is often not or only partially confirmed.

In spite of this evidence for the association between work characteristics and mental health, our understanding of the possible *causal* linkage between the DC/S dimensions and mental health remains limited, due to several methodological limitations of these earlier studies (cf. Kompier, 2002; Taris & Kompier, 2003; Zapf et al., 1996). This thesis aims to overcome these limitations and to provide more information about the causal nature of the relationship between the psychosocial work characteristics and indicators of mental health. Before addressing these limitations it is important to discuss the concept of causality.

1.2 Causality and longitudinal research

Causal relations are not mere correlations and involve some kind of natural necessity (Hollis, 1995), but how can this necessity be demonstrated? Philosophers already addressed this question in the eighteenth century. For example, David Hume claimed that causal relations can never be *proved*, but can be made more plausible through observation and experiment, thus linking a cause to its effect (Hollis, 1995). Moreover, the "human eye" can only observe that two events occur together or at best follow upon one another and we therefore interpret a sequence between two events in causal terms if it is repeatable (Hollis, 1995). We could try and unravel causal relations by examining organisational processes in a controlled laboratory setting, but these artificial locations can never match our real-life work setting and do not allow examining the effects of continuous exposure to stressful work environments (Chmiel, 2000). Therefore, we usually study the effects of work characteristics on worker health within the naturalistic setting of the work situation using quasi-experimental designs (Cook & Campbell, 1979), comparing for example respondents with and without job changes. In these field studies, causal inferences regarding the relationship between two concepts (e.g., job change and job satisfaction) may be drawn if four conditions are met (Cook & Campbell, 1979; Kenny, 1975; Taris, 2000). This research should: i) demonstrate that the cause variable precedes the outcome variable in time, ii) show a significant statistical relation between the presumed cause and outcome, iii) exclude possible alternative explanations, and iv) provide a theoretical interpretation of the relationship(s) under study.

1.2.1 What are the results of (high-quality) longitudinal research?

Unfortunately, the majority of the studies examining the Demand-Control-(Support; DC/S) model is based on a single time point or cross-sectional design (cf. van der Doef & Maes, 1998, 1999; de Jonge & Kompier, 1997; Schnall et al., 1994). For example, 53 of the 63 studies reviewed by Van der Doef and Maes (1999) were based on a cross-sectional design. Studies using cross-sectional designs do not meet the aforementioned time precedence criterion and therefore such studies do not support *causal* inferences. One way to overcome this limitation is to conduct a longitudinal (complete) panel study (see Figure 1.2 for a typical 4-wave panel study). This type of design is based on repeated (two or more) measurements of the same respondents and variables and can therefore make causality more plausible compared to the 'snap-shot assessment' in cross-sectional research, in which we cannot determine the temporal order of the research variables. Moreover, longitudinal designs facilitate a researcher to explore the strength, direction and magnitude of the cross-lagged relations (i.e., relations across time) between the variables of interest (Bijleveld et al., 1998; Kessler & Greenberg, 1981; Menard, 2002; Taris, 2000; Williams & Podsakoff, 1989; Zapf et al., 1996). Longitudinal designs can therefore be used to study how and why a relation between variables exists in relation to aspects of stability and change across time (Nesselroade & Baltes, 1979). For example, do the DC/S dimensions change across time and do these changes result in a subsequent change in mental health? Furthermore, are these changes the same for every (group of) worker(s)? In other words, questions of intra- and inter-individual stability and change can be examined using a longitudinal design. *As this thesis aims at disentangling the cross-lagged relation between the psychosocial work characteristics and mental health we will use a four-wave panel study to shed more light on the causal nature of this relation*.

The particular advantage of this *four-wave* design is that it has fewer problems with regression towards the mean (as the error fluctuations will be cancelled out in the average score; Rogosa, 1979), and can provide more information about the stability and change of the variables and cross-lagged (i.e., over time) relations than two-wave or cross-sectional designs (Taris & Kompier, 2003). Consequently, multi-wave panel designs permit even stronger conclusions about possible causal relations between work characteristics and mental health.

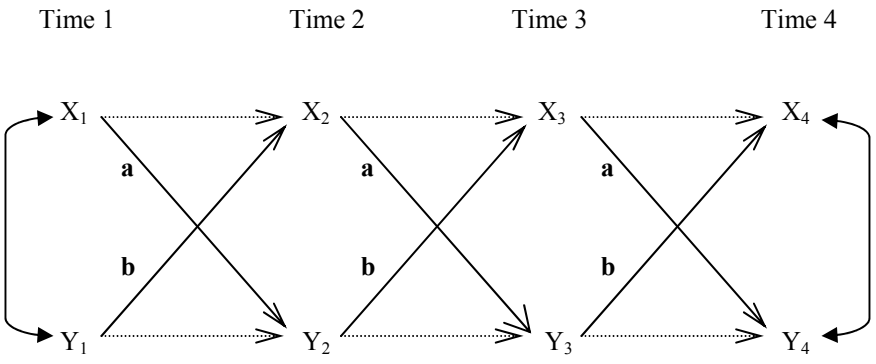


Figure 1.2

A longitudinal 4-wave panel study

Nb. X_1 ($X_{2, 3, 4}$) = variable X as measured on time 1 (time 2, 3, 4), Y_1 ($Y_{2, 3, 4}$) = measure of variable Y as measured on time 1 (time 2, 3, 4); a = (normal) cross-lagged effects from X to Y; b= (reversed) cross-lagged effects from Y to X.

Many occupational health researchers have acknowledged the benefits of longitudinal research and used this methodology to study the effects of work characteristics on (mental) health (Taris & Kompier, 2003; Zapf et al., 1996). Nonetheless, a systematic review of the published longitudinal studies examining the Demand-Control-(Support) model is still lacking. The question remains whether these studies provide consistent evidence for cross-lagged effects of the psychosocial work characteristics on (mental) health. Further, earlier reviews usually did not take the methodological quality of the studies into account, which may bias the results (Kristensen, 1995). This thesis will therefore start with the first unresolved issue of earlier research examining the DC/S model*:*

1) *What are the results of methodologically high-quality longitudinal research examining the DC/S model? Do these high-quality studies provide consistent evidence for cross-lagged relationships between the DC/S dimensions and (mental) health?*

1.2.2 Three types of causation in the relation between work and mental health?

Another problem with current longitudinal research concerns the issue of the causal direction of the relationship between the work characteristics and mental health. Apart from "standard" or *normal* causal relationships (i.e., work characteristics influence mental health), the relation between work and mental health can also be explained by *reversed* causal relationships, where Y (mental health) influences X (job characteristics) across time, or *reciprocal* causal relationships, where X and Y mutually influence each other (Menard, 2002). The a priori classification of variables as either "cause" and "effect" in the majority of the cross-sectional studies examining the DC/S model hinders the examination of the causal direction, in the sense that one measurement does not provide any information about which cross-lagged effect might be causally predominant (is it the normal or reversed effect, or both?). This limitation is not exclusive to DC/S studies, but can also be applied to more general organisational research (Hurrell et al., 1998; Taris & Kompier, 2003). For example, a meta-analysis by James and James (1989) revealed that of 55 articles examining various organisational behavior topics, 71 percent was based on a cross-sectional design and only 7 studies (13%) examined non-recursive or reciprocal effects. Similarly, Zapf and colleagues (1996) showed that only 15 of 39 articles examining organisational stress outcomes tested reversed causal effects (of which seven studies also found evidence). Research into reversed or reciprocal causality is thus far not popular in occupational health research. Yet, these causal relationships present important alternative explanations for the relation between work characteristics and mental health, and these may have different scientific as well as practical implications. For example, evidence for reversed causal relationships only, would result in rejection of the strain hypothesis of the DC/S model and would suggest more person-directed interventions to reduce this reversed effect.

2) *Consequently, this thesis will address this unresolved issue by testing which type(s) of causal relationship(s; normal, reversed or reciprocal) exist(s) between the DC/S dimensions and mental health.*

1.2.3 Which length of Time lag(s) is (are) correct?

The assumption that longitudinal data is "better compared to cross-sectional data" should be qualified further, as repeated measurement is no panacea for addressing the issue of causality. Before drawing causal inferences, researchers should address other design aspects like the temporal lag employed in the study (Menard, 2002). It is crucial in designing longitudinal panel studies, that the measurement interval (or temporal lag) that is applied corresponds with the "causal interval" of the process under study (James & James, 1989; Leventhal & Tomarken, 1987; Taris & Kompier, 2003). How long does it take before one can measure the impact of high job demands and low control on mental health? Should the "correct" time frame be long or short to measure this impact? A long time interval implies that there may be many in between changes in the work environment, some of which will not have been measured in the study, thus potentially confounding results. A short interval implies that no real changes may have taken place, implying that there is no reason to expect change in the study outcomes. Researchers should consider this question, as too short as well as too long time lags result in an underestimation of the true causal effects (Frese & Zapf, 1988). As early as 1975, David Kenny noted that: "Normally the lag between measurements is chosen because of convenience not theory, since theory rarely specifies the causal lag" (p. 894). Likewise, the few longitudinal studies examining the DC/S model seem to base their time lags on convenience and not theory (see Chapter 2).

There is quite some diversity in the time lags employed and the recommendations made for these time lags in examining longitudinal relationships between work and well-being (Williams & Podsakoff, 1989; Zapf et al., 1996). While Zapf et al. (1996) recommend that the same time lag be used if a study includes more than two measurements, Frese (1984) argues that in such cases processes may be better captured using different time lags. One way to provide more information about the correct length of a time lag for a particular relationship is to examine as many different causal lags as possible (with the potential risk of increasing drop-out across time; Kessler & Greenberg, 1981; Rogosa, 1979). An example of this method is the study of Dormann and Zapf (1999), who compared findings on the effects of work characteristics on worker well-being for several time lags (4-month, 8-month and 1-year intervals, respectively). They only found effects for an 8-month time lag when examining the moderating effects of social support by supervisors and colleagues in the relationship between social stressors at work and depressive symptoms.

Recently, Dormann and Zapf (2002) examined this question more thoroughly in a 4-wave study and found that a time lag of at least 2 years (compared to 4-year time lags) was adequate for demonstrating a relationship between social stressors at work, irritation, and depressive symptoms.

3) *This thesis will address the unresolved length of time lag(s) issue by answering the following question: which length(s) of time lag(s) (is) are needed for demonstrating the relationship between the DC/S dimensions and mental health?*

1.2.4 Can exposure history account for normal cross-lagged effects?

When examining these different causal relationships it is also important to understand the underlying mechanisms responsible for these effects. Earlier reviews have shown statistical main or interaction effects of one or more of the psychosocial work characteristics on various health outcomes (cf. Van der Doef & Maes, 1998; 1999), but these results do not shed light on possible underlying mechanisms. A possible mechanism discussed by Karasek and Theorell (1990) is *exposure history*. Karasek and Theorell (1990) have argued that long-term or cumulative exposure to a high strain job has comparatively stronger detrimental strain effects than short-term exposure (also labelled as *exposure time* effect, Frese & Zapf, 1988). Consequently, the detrimental effects of being in a high-strain job should be more pronounced for workers who were exposed longer to a stable high-strain job compared to workers exposed to stable low-strain, active or passive jobs. This process has also been addressed by Meijman and Mulder (1998) in their Effort-Recovery (E-R) model. A central assumption of the E-R model is that workers will invest effort in a particular job, resulting in psychological and physiological responses from which they will need to recover (during breaks or non-work time). However, if workers are continuously or repeatedly exposed to a working environment with high demands and low control (and social support) they will have less recovery time and, as a consequence, will need to invest even more effort to perform well at their jobs. In other words, the effort-recovery imbalance in high strain jobs might explain the associated increasing detrimental (mental) health effects (in line with the strain hypothesis of the DC/S model).

On the other hand, workers may also have been exposed to changes in their work environments that may influence their chances of recovery (de Jonge & Kompier, 1997; Taris & Kompier, 2003). Many workers experience rapid changes in their jobs and it is

important to learn more about the effects of these different *exposure histories* on mental health (Schrabracq, 2003). Does change or stability in the work environment lead to subsequent across-time change in worker health? Few researchers have examined the issue of stability and change of exposure to work characteristics (de Jonge & Kompier, 1997; Landsbergis & Theorell, 2000). Frese and Zapf (1988) noted that people differ in their amount of exposure (as a result of, for example, a different job history) and recommended examining different subgroups, but did not formulate specific methods for analysing these subgroups. One exception in this field is a study by Schnall and coworkers (1998), who used an interesting way of analysing stability and change in exposure by creating four "exposure profiles", including two stable exposure profiles (i.e., workers who were in the "high strain" condition at both waves of their study, and workers who were in the "no-high strain" condition at both occasions) and two changing exposure profiles (i.e., workers who moved from the "high strain" condition to the "no-high strain" condition, and vice versa). They found results in line with the strain hypothesis of the DC/S model.

4) *Similarly, this thesis will pay attention to this unresolved issue by examining effects in work characteristics for subgroups with "stable" versus "changing" exposure histories.*

1.2.5 Which mechanisms can account for reversed cross-lagged effects?

It is also important to explain and understand the reversed causal effects from mental health on work characteristics across time. As yet, there has been little theorizing on the mechanisms that account for this relationship. In this thesis our point of departure is that reversed effects of mental health status can be due to either *real* positive or negative changes of the work environment (environmental changes) or to changes of the *evaluation* of the *same* work environment (perceptual changes). For example, depressed workers may be less capable in retaining a favourable work environment (environmental change) or they may perceive the same work environment as less favourable (perceptual change; Frese & Zapf, 1988). We will therefore distinguish, explain and test different mechanisms that can be seen as environmental change versus perceptual change mechanisms.

5) *This thesis pays attention to the reversed causation issue by summarizing results of earlier studies examining reversed effects and conducting an empirical test of different environmental versus perceptual change mechanisms.*

In sum, as yet, there is little information available about the causal nature and direction of the relationship between the DC/S dimensions and mental health. We do not know: i) whether earlier high-quality longitudinal research found consistent cross-lagged relations between the DC/S dimensions and mental health, ii) which type(s) of causal relation(s) exist(s) between the DC/S dimensions and mental health (normal, reversed or reciprocal?), iii) the length of the time lag(s) needed to find significant cross-lagged relations between the DC/S dimensions and mental health, iv) whether duration of exposure can explain normal lagged relations, and v) which mechanism(s) can explain possible reversed lagged relations. These unresolved issues result in various research questions that will be addressed in this thesis (see Table 1.1).

1.3 Empirical data: SMASH study

To determine the causal nature and direction of the relationship between the psychosocial work characteristics and mental health, this thesis will (besides presenting a systematic review of previous studies in Chapter 2) examine the (cross-lagged) relations between the work characteristics and mental health within the framework of the prospective Dutch 4-wave cohort study on musculoskeletal disorders, absenteeism, stress and health (SMASH). This study was initiated in 1993 by TNO Work & Employment in order to identify work-related risk factors for musculoskeletal complaints. From 34 different companies, located throughout the Netherlands, 2064 workers were invited to participate in SMASH. The companies included various industrial and service sectors and were recruited in cooperation with Occupational Health Services. Of the invited workers, 1789 responded to the baseline measurement (86.7%). Both blue-collar jobs and white-collar jobs were included.

Table 1.1

Unresolved issues and associated research questions of this thesis

Unresolved issues earlier research	Research questions	Results in Chapter?
1 What are the results of (high-quality) longitudinal research?	*Question 1A*: How many previous longitudinal studies examining the DC/S model meet five important methodological criteria and can therefore be labelled as *high-quality* studies? *Question 1B*: What are the results of these high-quality longitudinal studies as regards the propositions advanced in the DC/S model? Do these high-quality studies provide evidence for normal (instead of reversed or reciprocal) causal relationships between Time 1 demands, control, or social support and Time 2 health outcomes?	Chapter 2
2 Three types of causation in the relation between work and mental health?	*Question 2:* Which causal relationship(s) exist(s) between the DCS measures and mental health?	Chapter 3
3 Which length of Time lag(s) is (are) correct?	*Question 3*: Which time lag shows the strongest results for demonstrating the relationship between the DCS dimensions and mental health across time?	Chapter 3

-Table 1.1 continued-

Unresolved issues earlier research	Research questions	Results in Chapter?
4 Can exposure history account for normal cross-lagged effects?	*Question 4A*: Are Karasek's predictions for the differences in strain between the four different job types (high strain, low strain, active and passive work) supported for groups with stable exposure to demands and control? *Question 4B:* Do positive (negative) changes in exposure to demands and control result in decreased (increased) strain levels across time, in agreement with the predictions of the demand-control model? *Question 4C*: Can change in reported exposure to demands and control be linked to "objective" change in the work environment?	Chapter 4
5 Which mechanisms account for reversed cross-lagged effects?	*Question 5*: Which environmental or perceptual change mechanism(s) can explain the reversed lagged effect of mental health on the DCS dimensions?	Chapter 2,5

In order to be included, companies were required not to be involved in major reorganizations during the three years of examination and the prestudy annual turnover rate of their workforce should be lower than 15%. Further, only respondents were selected who had been working for at least one year and had a permanent contract for at least 20 hours per week (in order to realize enough exposure to the current psychosocial work characteristics).

Each year (up to 1997; see Figure 1.3) the respondents received a self-administered questionnaire measuring concepts such as general work conditions, changes in the workplace, psychosocial work characteristics, job satisfaction, physical load at work, psychosocial and physical health, and various demographic variables. In addition, registered sickness absence was annually obtained (cf. Ariëns et al., 2001; Hoogendoorn et al., 2000). The data presented in this thesis are based on the questions measuring psychosocial variables and indicators of mental health[4] (see Chapter 3-5 for more information on the measures used).

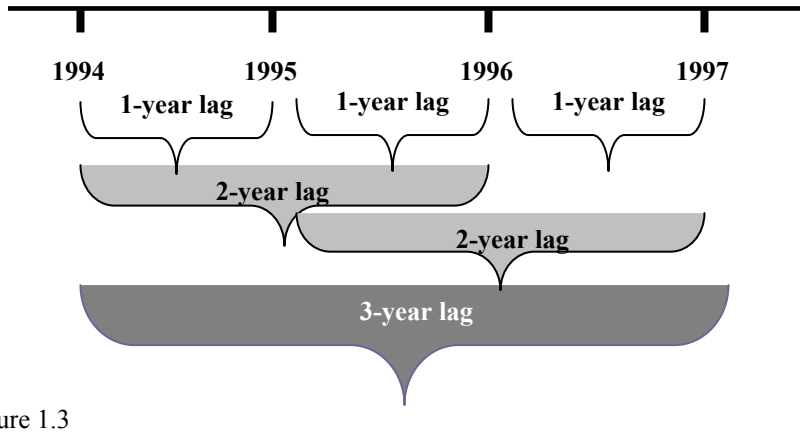


Figure 1.3

Longitudinal panel design of the SMASH (Study on Musculoskeletal disorders, Absenteeism and Health) study

[4] Chapter 4 also shows the SMASH study results for registered sickness absence duration and frequency.

1.4 Outline of this thesis

Table 1.1 shows the different chapters of this thesis containing the results of the various research questions. *Chapter 2* starts with reviewing earlier longitudinal research examining the DC/S model, in order to answer research questions 1A and 1B. This chapter presents a review of 45 longitudinal studies examining the demand-control (DC) or demand-control-support (DCS) model. Five criteria are formulated to distinguish the high-quality longitudinal studies, namely: i) type of design, ii) length of time lags, iii) quality of measures, iv) method of analysis and v) nonresponse analysis. The results of these high-quality studies are described in detail, providing information about the specific study (e.g. population, type of measurement used, types of causal relations tested etc.) and the results found as regards the propositions advanced in the DC/S model.

Chapter 3 presents the empirical results from the SMASH study for research questions 2 and 3: Testing normal, reversed and reciprocal causal relationships between the DCS dimensions and mental health (question 2) and examining which length of time lag (a 1-, 2- or 3-year wave, or combinations of these) suits these relationships (question 3). Structural equation modelling was used to test the different types of causation as this method of analysis can be used to determine whether the normal or the reversed causal relationship is causally predominant (Byrne, 2002; Rogosa, 1980).

Chapter 4 presents the empirical results for research questions 4A-C. This chapter aims at understanding the cross-lagged impact of work on mental health by examining the exposure history mechanism (questions 4A-B). By disentangling stability and change in exposure to combinations of demands and control, we can examine effects of cumulative versus across-time change in exposure to these work characteristics. A relatively new method of analysing exposure history was used. Subgroups with different exposure profiles (stable and meaningful across-time change groups) were distinguished and examined across the 4 waves of the SMASH study. In addition, we examined whether the change in the reported exposure to demands and control could be linked to “objective” (real) change in the work environment (question 4C).

Chapter 5 explores and tests possible theoretical mechanisms for reversed effects of mental health on work across time (answering question 5). As we mentioned earlier, evidence for mechanisms underlying reversed effects is scarce. We have therefore formulated and tested four perceptual change versus four environmental change

mechanisms. To discriminate between these environmental and perceptual change mechanisms we examined subgroups with and without job changes.

In *Chapter 6* all results for questions 1-5 are summarized and theoretical implications from these results are discussed. Furthermore, recommendations for future longitudinal research examining cross-lagged relations between work characteristics and (mental) health are formulated. Chapter 6 ends with the practical implications of this thesis.

References

Andries, F., Houtman, I., & Hupkens, C. (2004). Kerncijfers Arbeid. In I. L. D. Houtman, P. G. W. Smulders & D. J. Klein Hesselink (Ed.). *Trends in arbeid 2004* (pp. 45-63). Hoofddorp: TNO Arbeid.

Ariëns G. A. M., Bongers P. M., Miedema M. C., Van der Wal G., Bouter L. M., & Van Mechelen, W. (2001). Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study in occupational setting. *Journal of Occupational and Environmental Medicine, 58*, 200-207.

Belkić K., Landsbergis P. A., Schnall P. L., & Baker D. (2004). Is job strain a major source of cardiovascular disease risk? A critical review of the empirical evidence, with a clinical perspective. *Scandinavian Journal of Work, Environment and Health, 30*, 85-128.

Bijleveld, C. J. H., & Van der Kamp, L. J. T. (1998). *Longitudinal Data Analysis. Designs, Models and Methods.* Londen, Sage publications Ltd.

Byrne, B.M. (2002). *Structural equation modeling with AMOS*. Mahwah, NJ: Lawrence Erlbaum.

Chmiel, N. (2000). History and Context for Work and Organizational Psychology. In N. Chmiel (Ed.), *Introduction to Work and Organizational Psychology. A European Perspective* (pp 4-19). Oxford, UK*:* Blackwell Publishers.

Cook, T.D., & Campbell, D.T. (1979). *Quasi-experimentation: Design and analysis for field settings.* Boston: Houghton Mifflin.

Van der Doef, M. P., & Maes, S. (1998). The Job Demand-Control(-Support) Model and physical health outcomes: A review of the strain and buffer hypotheses. *Psychology and Health, 13,* 909-36.

Van der Doef, M. P., & Maes, S. (1999). The Job Demand-Control(-Support) Model and psychological well-being: A review of 20 years of empirical research. *Work & Stress, 13,* 87-114.

Dormann, C., & Zapf, D. (1999). Social support, social stressors at work, and depressive symptoms: Testing for main and moderating effects with structural equations in a three-wave longitudinal study. *Journal of Applied Psychology, 84*, 874-884.

Dormann, C., & Zapf, D. (2002). Social stressors at work, irritation, and depressive symptoms: Accounting for unmeasured third variables in a multi-wave study. *Journal of Occupational and Organizational Psychology, 75*, 33-58.

Frese, M. (1984). Job transitions, occupational socialisation and strain. In V. Allen & E. van de Vliert (Eds.), *Role transitions.* New York: Plenum Press.

Frese, M., & Zapf, D (1988). Methodological issues in the study of work stress: Objective vs subjective measurement of work stress and the question of longitudinal studies.

In C. L. Cooper & R. Payne (Eds.), *Causes, coping and consequences of stress at work* (pp. 375-411). Chichester: John Wiley & Sons Ltd.

Harnois, G., & Gabriel, P. (2000). *Mental health and work: Impact issues and good practices.* Joint document of the World Health Organisation and the International Labour Organisation. Geneva: WHO/MSD/MPS/00.2

Hollis, M. (1995). *The philosophy of social science.* Cambridge: Cambridge University Press.

Hoogendoorn, W.E., Bongers, P.M., De Vet, H.C.W., Douwes, M., Koes, B.W., Miedema, M. C., Ariëns, G. A. M., & Bouter, L. M.(2000). Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective cohort study. *Spine, 25,* 3087-3092.

Houtman, I. L. D., & Kompier, M. A. J. (1998). Work and mental health. In J. M. Stellman (Ed.). *Encyclopaedia of occupational health and safety* (4th edition, pp. 5.2-5.5). International Labour Office: Geneva.

Houtman, I., Kornitzer, M., De Smet, P., Koyuncu, R., De Backer, G., Pelfrene, E., Romon, M., Boulenguez, C., Ferrario, M., Origgi, G., Sans, S., Perez, O. Wilhelmsen, L., Rosengren, A., Isacsson, S., & Östergren, P. (1999). Job stress, absenteeism and coronary heart disease European cooperative study (the JACE study). *European Journal of Public Health, 9*, 52-57.

Hurrell, J. J., Nelson, D. L., & Simmons, B. (1998). Measuring job stressors and strains: where we have been, where we are and where we need to go. *Journal of Occupational Health Psychology, 3*, 368-389.

James, L. R., & James, L. A. (1989). Causal modelling in organizational research. In C. L. Cooper & I. T. Robertson (Eds.), *International Review of Industrial and Organizational Psychology* (pp. 371-404). New York: John Wiley & Sons Ltd.

De Jonge, J., & Kompier, M.A.J. (1997). A critical examination of the Demand-Control-Support Model from a work psychological perspective. *International Journal of Stress Management, 4*, 235-258.

Johnson, J. V., & Hall, E. M. (1988). Job strain, work place social support, and cardiovascular disease: A cross-sectional study of a random sample of the Swedish working population. *American Journal of Public Health, 78,* 1336-1342.

Karasek, R. A. (1976). *The impact of the work environment on life outside the job*. Unpublished doctoral dissertation, Massachusetts Institute of Technology (Available from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. Thesis Order: No. PB 263-073)

Karasek, R. A. (1979). Job demands, job control, and mental strain: Implications for Job redesign. *Administrative Science Quarterly, 24,* 285-308.

Karasek, R. A. (1985). *Job Content Instrument: Questionnaire and user's guide*. Los Angeles: Department of Industrial and Systems Engineering, University of Southern California.

Karasek, R., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life*. New York: Basic Books.

Kenny, D. A. (1975). Cross-lagged panel correlation: A test for spuriousness. *Psychological Bulletin*, *82*, 887-903.

Kessler, R. C., & Greenberg, D. F. (1981). *Linear panel analysis. Models of quantitative change.* New York: Academic Press.

Kompier, M. A. J. (2002). The psychosocial work environment and health-what we know and where we should go? *Scandinavian Journal of Work, Environment and Health*, *28,* 1-4.

Kompier, M. A. J. (2003). Job design and well-being. In M.J. Schrabracq, J. A.M. Winnubst & C.L. Cooper (Eds.), *The handbook of work & health psychology* (pp. 429-454*)*. Chichester: John Wiley & Sons Ltd.

Koningsveld, E.A.P., Zwinkels, W.S., Mossink, J.C.M., Thie, X.M., & Abspoel, M. (2003). *Maatschappelijke kosten van arbeidsomstandigheden van werknemers in 2001*. Ministry of Social Affairs, The Netherlands.

Kristensen, T. S. (1995). The Demand-Control-Support model: Methodological challenges for future research. *Stress Medicine, 11,* 17-26.

Landsbergis, P. A. (2003). The changing organization of work and the safety and health of working people: A commentary. *Journal of Occupational Environmental Medicine, 45*, 61-72.

Landsbergis, P., & Theorell, T. (2000). Measurement of psychosocial workplace exposure variables. *Occupational medicine: State of the art reviews, 15*, 163-188.

Le Blanc, P., de Jonge, J., & Schaufeli, W. (2000). In N. Chmiel (Ed.), *Introduction to Work and Organizational Psychology. A European Perspective* (pp. 148-178). Oxford, UK: Blackwell Publishers.

Leventhal, H., & Tomarken, A. (1987). Stress and Illness: Perspectives from health psychology. In S.V. Kasl & C.L. Cooper (Eds.), *Research Methods in Stress and Health Psychology* (pp. 27-55). John Wiley & Sons Ltd, England.

Meijman, T. F., & Mulder, G. (1998). Psychological aspects of workload. In P. J. Drenth, H. K. Thierry, Ch. J. de Wolff (Eds.). *Handbook of Work and Organizational Psychology* (2nd ed., pp. 5-33). Hove, England UK: Psychological Press/ Erlbaum.

Menard, S. (2002). *Longitudinal research*. London: Sage Publications, Inc.,

National Institute for Occupational Safety and Health (NIOSH). *The changing Organization of Work and the Safety and Health of Working People.* Cincinnati: NIOSH. Report No.: 2002.

Nesselroade, J. R., & Baltes, P. B. (Eds., 1979). *Longitudinal research in the study of behavior and development*. New York: Academic Press.

Paoli, P, & Merllié, D. (2001). *Third European survey on working conditions*. Luxembourg: European Foundation for the improvement of Living and Working conditions.

Rogosa, D. (1979). Causal models in longitudinal research: rationale, formulation, and interpretation. In J. R. Nesselroade & P. B. Baltes (Eds.). *Longitudinal research in the study of behavior and development*(pp 263-301). New York: Academic Press, 263-301.

Rogosa, D. (1980). A critique of cross-lagged correlation. *Psychological Bulletin, 88*, 245-258.

Schaufeli, W., & Bakker, A. (2001). Werk en welbevinden. Naar een positieve benadering in de arbeids- en gezondheidspsychologie. ["Work and well-being: towards a positive Occupational Health Psychology"] *Gedrag en Organisatie, 14*, 229-253.

Schaufeli, W. B., & Kompier, M. A. J. (2001). Managing job stress in the Netherlands. *International Journal of Stress management, 8*, 15-34.

Schnall, P. L., Belkić, K., Landsbergis, P., & Baker, D. (2000). The workplace and cardiovascular diseases. *Occupational medicine: State of the art reviews, 15*, 163-188.

Schnall, P. L., Landsbergis, P. A., & Baker, D. (1994). Job strain and cardiovascular disease. *Annual Review of Public Health, 15,* 381-411.

Schnall, P. L., Schwartz, J. E., Landsbergis, P. A., Warren, K., Pickering, T. G. (1998). A longitudinal study of job strain and ambulatory blood pressure: Results from a three year follow-up. *Psychosomatic Medicine, 60*, 697-706.

Schrabracq, M. J. (2003). Everyday well-being and stress in work and organisations. In M. J. Schrabracq, J. A. M. Winnubst, & C. L. Cooper (Eds.), *The handbook of work & health psychology* (pp 9-36). Chichester, UK: John Wiley & Sons Ltd.

Schrabracq, M. J., Cooper, C. L. & Winnubst, J. A. M. (2003). Introduction. In M. J. Schrabracq, J. A. M. Winnubst, & C. L. Cooper (Eds.), *The handbook of work & health psychology* (pp 1-8). Chichester, UK: John Wiley & Sons Ltd.

Spector, P.E. (1992). A consideration of the validity and meaning of self-report measures of job conditions. In C. L. Cooper & I. T. Robertson (Eds.), *International Review of Industrial and Organizational Psychology* (pp. 123-151). New York: John Wiley & Sons Ltd.

Taris, T. W. (2000). *A primer in longitudinal data analysis*. Londen: Sage.

Taris, T. W., & Kompier, M. A. .J. (2003). Challenges in longitudinal designs in occupational health psychology. *Scandinavian Journal of Work, Environment and Health, 29*, 1, 1-4.

Taris, T. W., & Kompier, M. A. J. (2004). Job characteristics and learning behavior. In P. L. Perrewé & D. C. Ganster (Eds.), *Research in Occupational Stress and Well-being: Exploring interpersonal dynamics*, vol. 4. (pp. 127-166). Amsterdam: JAI Press.

Taris, T. W., Kompier, M. A. J., Lange, A. H., de, Schaufeli, W. B., & Schreurs, P. J. G. (2003). Learning new behaviour patterns: a longitudinal test of Karasek's active learning hypothesis among Dutch teachers. *Work & Stress*, *1*7, 1-20.

Tennant, C. (2001). Work-related stress and depressive disorders. *Journal of Psychosomatic Research, 51*, 697-704.

Theorell, T. (1999). How to deal with stress in organizations?- a health perspective on theory and practice. *Scandinavian Journal of Work, Environment and Health, 25*, 616-624.

Van Horn, J.E., Taris, T.W., Schaufeli, W.B. & Schreurs, P.J.G. (2004). The structure of occupational well-being: A study among Dutch teachers. *Journal of Occupational and Organizational Psychology, 77*, 365-375.

Warr, P.B. (1987). *Work, unemployment, and mental health*. Oxford: Oxford University Press.

Warr, P.B. (1994). A conceptual framework for the study of work and mental health. *Work & Stress*, 8, 84-97.

Williams, L.J., & Podsakoff, P.M. (1989). Longitudinal field methods for studying reciprocal relationships in organizational behavior research: toward improved causal analysis. *Research in Organizational Behavior, 11*, 247-292.

Zapf, D., Dormann, C., & Frese, M. (1996). Longitudinal studies in organizational stress research: A review of the literature with reference to methodological issues. *Journal of Occupational Health Psychology, 1,* 145-16

2

The *very* best of the millenium: Longitudinal research and the Demand-Control-(Support) model

Appeared as:

De Lange, A. H., Taris, T. W., Kompier, M. A. J., Houtman, I. L. D., Bongers, P. M. (2003). The *very* best of the Millennium: Longitudinal research and the Demand-Control-(Support) model. *Journal of Occupational Health Psychology*, *8*, 282-305.

Chapter 2

2.1 Abstract

This study addressed the methodological quality of longitudinal research examining R. Karasek and T. Theorell's (1990) Demand-Control-(Support) model and reviewed the results of the best of this research. Five criteria for evaluating methodological quality were used type of design, length of time lags, quality of measures, method of analysis; and nonresponse analysis. These criteria were applied to 45 longitudinal studies, of which 19 (42%) obtained acceptable scores on all criteria. These high-quality studies provided only modest support for the hypothesis that especially the combination of high demands and low control results in high job strain. However, good evidence was found for lagged causal effects of work characteristics, especially for self-reported health and/or well-being outcomes.

2.2 Introduction

Karasek´s (1979) Demand-Control (DC) model has been a leading work stress model in occupational health psychology since the 1980s. According to the model, a psychological work environment can be characterized by a combination of job demands and job control. Especially the combination of high job demands and low job control ("high strain jobs") is assumed to result in psychological stress reactions, such as high blood pressure and low job satisfaction. Conversely, low strain jobs (characterized by low demands and high control) will lead to a lower than average number of health complaints (the *strain* hypothesis; Karasek, 1979; Karasek & Theorell, 1990). As Johnson and Hall (1988) had noted in previous research that support received from supervisor and colleagues often buffered the impact of demands and control on outcome variables, they proposed to extend the DC model with social support, resulting in the Demand-Control-Support (DCS) model. The predictions of the DCS model strongly resemble those of the DC model, assuming that the strain hypothesis of the DC model will especially apply under conditions of low support.

A large body of research has tested the strain hypothesis. The results thereof did not always support the hypothesis (for reviews see, de Jonge & Kompier, 1997; Houtman et al., 1999; Kasl, 1996; Kristensen, 1996; Theorell & Karasek, 1996; Schnall, Landsbergis, & Baker, 1994; van der Doef & Maes, 1999). For example, van der Doef and Maes´s (1999) review showed that only 28 of 41 studies examining the relationship between job characteristics and psychological well-being supported the strain hypothesis. They reported comparable results for other outcomes. Van der Doef and Maes (1999) also reviewed the iso-strain hypothesis (the counterpart of the strain hypothesis in the DCS model) in 19 studies: only 9 of these supported the association between the three job characteristics and psychological well-being.

Thus, it appears that the Demand-Control-(Support) (or DC/S) model is not unequivocally supported. However, earlier reviews of the DC/S model suffered from several shortcomings that restrict the conclusions that can be drawn from these. First, they usually did not take the methodological quality of studies into account, which may bias the results (Kristensen, 1995). This may be an important reason for the inconsistent results presented in these reviews. It is possible that especially methodologically weak studies failed to support the predictions of the DC/S model. For example, a high and selective nonresponse may result in restriction of range-effects for both the independent and outcome

variables, meaning that the magnitude of associations between these variables is underestimated (Taris, 2000).

A second limitation of earlier reviews is that they were primarily based on cross-sectional studies. For example, 53 of the 63 studies reviewed by van der Doef and Maes (1999) used a cross-sectional design. Such designs are ill-suited to test *causal* relationships, because they cannot provide any evidence regarding the temporal order of the variables. Although statistical techniques such as structural equation modeling (SEM) may provide an indication of the causal direction of particular pathways in cross-sectional research, strong evidence on the causal order of variables requires a longitudinal design (Cook & Campbell, 1979; Taris & Kompier, 2003). Further, cross-sectional designs do not allow for examining *reversed* and *reciprocal* causal relationships. In occupational health research it is often assumed that job characteristics (e.g., demands and control) influence health. Apart from these "standard" causal relationships, longitudinal designs often offer the possibility to examine the effects of Time 1 health on (the evaluation of) Time 2 job demands and control (reversed causal relationships, Zapf, Dormann, & Frese, 1996). This also implies that cross-sectional designs are ill-suited for exploring reciprocal causal relationships, in which variable X (e.g., job characteristics) and Y (e.g., health) mutually influence each other. Such relationships should be controlled for, as they may provide alternative explanations for certain associations between variables. Given the paucity of longitudinal studies in the reviews on the DC/S model, it seems fair to say that they provide little empirical material that supports causal interpretation of the associations among job demands, control, support, and health. Indeed, given the absence of studies examining reversed or reciprocal causal relationships at present, any such interpretation would seem mere speculation.

Finally, it is somewhat disquieting to note that earlier reviews did not clearly define which pattern of results is required to justify the conclusion that there is "... a *joint* (italics added) effect of demands and control on outcomes measured over time" (Karasek, 1979, p. 287). Therefore, in the present review a definition of support of the strain hypothesis is proposed.

The present study aims to circumvent these limitations by (a) providing a definition of support of the strain hypothesis, (b) by examining high-quality longitudinal research on the DC/S model exclusively, and (c) by examining evidence for standard, reversed and reciprocal causal relationships between work and health. By including only

methodologically best studies, we intend to select the most reliable and valid results for inclusion in our review. By focusing on longitudinal research, we aim to provide an empirically sound basis for conclusions on the causal effects of job characteristics on health. Thus, this study aimed to provide a review of the results of the best longitudinal studies to date on the DC/S model, assuming that the material presented in these studies is exceptionally valuable in enhancing our understanding of the causal effects of job characteristics on worker health. Specifically, we deal with the following questions:

1. *How many longitudinal studies examining the DC/S model meet five important methodological criteria and can therefore be labeled as high-quality studies?*
2. *What are the results of these high-quality longitudinal studies as regards the propositions advanced in the Demand-Control-(Support) model? Moreover, do these high-quality studies provide evidence for normal (instead of reversed or reciprocal) "causal" relationships between Time 1 Demands, Control or Social support and Time 2 health outcomes?*

2.2.1 When is the strain hypothesis of the DC/S model supported?

One important issue that has as yet not been dealt with satisfactory elsewhere concerns the issue when the strain hypothesis of the DC/S model is supported. Karasek (1989) states that true (i.e., multiplicative) interaction effects are often difficult to detect because of lack of statistical power. He then argues that "the exact form of the interaction term is not the main issue, since the 'primary' interaction claimed in the model is that two separate sets of outcomes (strain and activity level) are jointly predicted by two different combinations of demands and control" (p. 143). Further, Karasek claimed that the practical implications for job redesign are similar for additive and interactive effects. This rather ambiguous formulation has generated some discussion whether the DC/S model is supported in the absence of significant multiplicative interaction terms of the DC/S dimensions: do additive effects (i.e., main effects only) suffice (cf. de Jonge & Kompier, 1997; Kasl, 1996; Landsbergis, Schnall, Warren, Pickering, & Schwartz, 1994; Schnall et al., 1994; van der Doef & Maes, 1999)?

With Karasek, we consider focusing on the multiplicative interaction only too narrow. We therefore suggest that future research uses a broad definition of support of the DC/S model. In the present article we propose that both additive (main effects only) or multiplicative interaction effects support the strain hypothesis of the DC/S model, provided that workers in the high demands/low control condition experience the highest levels of strain. More specifically, we consider the strain hypothesis of the DC model supported when there are two main effects of job demands and job control *and*/*or* when there is a multiplicative interaction effect between these two work characteristics (not in combination with a third variable), such that employees working in environments characterized by high demands and low control experience the highest level of strain. The strain hypothesis of the DCS model is supported when the above-mentioned additive or multiplicative interaction effects of demands and control are complemented with a main or interaction effect of social support (not in combination with a fourth variable), such that employees working in environments characterized by high demands, low control and low social support experience the highest level of strain.

2.2.2 Evaluation criteria

Five criteria were applied to answer Research Question 1 concerning the methodological quality of longitudinal studies examining the DC/S model. Criteria were based on common insights from general and longitudinal research methodology, referring to (a) type of longitudinal design; (b) length of the time lags between the waves of the study; (c) quality of the measures; (d) statistical analysis; and (e) non-response analysis (e.g., Nesselroade & Baltes, 1979; Zapf et al., 1996; Taris, 2000).

Design. Figure 2.1 presents a complete panel design for two variables X and Y (Zapf et al., 1996). In this design it is possible to examine cross-lagged effects (i.e., effects of variable X as measured on Time 1 on variable Y as measured on Time 2: for example, the effect of Time 1 demands on Time 2 health).

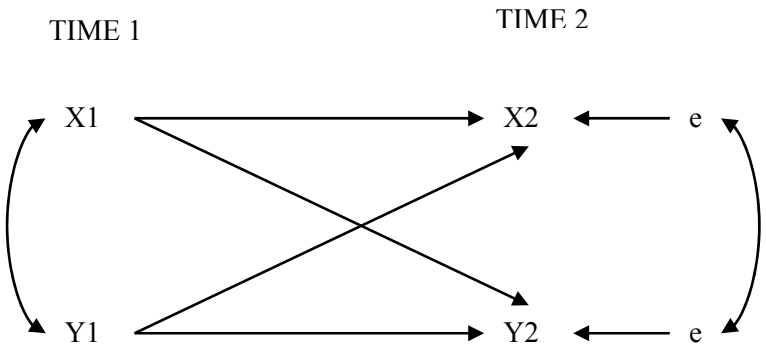


Figure 2.1

Complete panel design

Nb. X1 (X2) = variable X as measured on time 1 (time 2), Y1 (Y2) = measure of variable Y as measured on time 1 (time 2), e = measurement error.

Cross-lagged effects cannot be interpreted causally unless four criteria have been satisfied (Cook & Campbell, 1979; Taris, 2000): (a) there is a statistically significant association between X and Y; (b) the causal variable X precedes the effect variable Y in time; (c) the association between X and Y is not due to third variables; and (d) there is a plausible theoretical argument for the relationship between X and Y. When a study uses a full panel design, three kinds of causal relationships can be examined. First, *normal* or *standard causal relationships* are hypothesized effects of for instance Time 1 demands on Time 2 fatigue. This is the type of effect that is usually examined in occupational health research. Second, *reversed causal relationships* run opposite to the hypothesized effects; for instance, fatigue may alter the perceptions of one's job demands across time (when fatigued, persons may perceive their job demands as higher than when they are not fatigued). Finally, a study can examine *reciprocal causal relationships,* that is, whether (perceptions of) demands and fatigue mutually influence each other over time.

The advantage of a complete panel design compared to incomplete panel designs (in which not all study variables are measured on all time points) is that these three types of

causal relationships can be distinguished from each other, meaning that a fuller understanding of the causal process can be obtained. In practice many studies employ a panel design that includes measures of the independent and dependent variable on time 1 and a measure of the dependent variable on time 2. In this design only normal causal relationships can be tested; reverse or reciprocal effects cannot be examined (Zapf et al., 1996).

Time lags. A complete panel design is insufficient to demonstrate causal effects of variables over time, because the researcher still has to consider the length of the time lag that is needed to detect any effects. In general, there is little information available about the time lag that is needed for the causal variable to influence the effect variable (Taris & Kompier, 2003), and the recommendations concerning the length of this lag tend to be inconsistent. For example, while Zapf et al. (1996) prefer the same time lags when a study has more than two waves, Frese (1984) argues that when there are three or more measurements, some processes are better captured using time lags of different lengths. In the absence of commonly accepted guidelines on the correct length of time lags, researchers should discuss their choice for a particular time lag in the light of the question *how* the effect of X on Y develops over time (Frese & Zapf, 1988). Further, the choice for a particular time lag may also be based on the wish to control for alternative explanations for associations between variables, such as *interim effects* (i.e., effects of unobserved events during the time lag, such as a job change), *maturation effects* (e.g., effects due to increased experience) and *seasonal effects* (e.g., effects of measuring in summer or winter). In practice, the choice for a particular time lag is often motivated by the practical facilities of the research project or the time available to the researchers and the participants. However, such considerations should be complemented with plausible theoretical and/or methodological arguments.

Measures. Longitudinal research on the DC/S model usually employs a survey design. Therefore, the reliability of the instruments measuring job characteristics and outcome variables is an important issue in this review. The reliability of an instrument can be demonstrated by referring to journal articles in which the quality of this instrument is established or by calculating a reliability score (such as Cronbach's alpha) for one's own data.

One important problem of using survey data only is the risk of self-report bias, for example, due to personality traits such as negative affectivity (Schnall et al., 1994). By combining subjective self-report measures with objective measures, researchers can mitigate the effects of methodological and/or conceptual overlap between the measured variables, thus reducing the risk of falling in the "triviality trap" (Kristensen, 1996). A study is considered acceptable when it includes good references for and acceptable reliabilities of one's variables (alpha of around .70; Stangor, 1998, p. 92); it is *very* good if it includes an objective measure as well (e.g., a psychophysiological measure), provided that this measure reflects a salient facet of the employees' experience.

Method of analysis. Zapf et al. (1996) investigated 43 longitudinal studies and found that three main methods of statistical analysis were used: correlational research (e.g., the comparison of cross-lagged correlations), multiple regression and structural equation modeling (SEM). Comparison of cross-lagged correlations may yield erroneous conclusions (Taris, 2000). In correlational research it is difficult to demonstrate reversed or reciprocal causal relationships, as the cross-lagged correlations depend on the variances of the measured variables (Zapf et al., 1996) and the across-time stability of the variables (Kessler & Greenberg, 1981). Therefore, multiple regression analysis and SEM are preferred for analysing cross-lagged effects.

Nonresponse analysis. When conducting research among a particular population, researchers should examine the nonresponse in their study. Possible selectivity of the response may be investigated on the first measurement when the research group is selected, but also on the follow-up responses. A study is considered acceptable when it examines possible selectivity of the response on baseline and on the follow-up measurements (e.g., in terms of gender and age); it is very good when it examines whether the associations at baseline between the DC/S dimensions and the outcome variables differ for responders and non-responders (i.e., those who drop out of the study after baseline). This can be achieved by exploring the association between work and health at baseline for the response group versus the group that drops out after baseline.

Evaluation criteria. On the basis of these considerations, a system was developed to rate the methodological quality of studies (see Table 2.1 for a summary). In principle, studies could obtain 1 star ("insufficient") to 4 stars ("very good") for each criterion. As

regards method of analysis, however, studies received either 1 star (“insufficient”) or 3 stars (“good”), referring to the distinction between correlational research and multiple regression/SEM, respectively.

One important aspect of longitudinal research is the number of measurements of a study. More measurements result in more information about the variables and the relationships among these over time, meaning that the quality of a study increases with the number of measurements. This is reflected in the allotment of stars on the criteria “design” and “time lags”, respectively

2.3 Method

2.3.1 Study selection

We define "study" as any publication containing longitudinal research examining the DC/S model. Longitudinal studies examining the DC/S model were identified through a systematic database search. As Karasek first introduced the DC model in 1979, this year was chosen as our starting point. The databases searched were Medline (1979 to 1999), PsycInfo (1979 to 1999) and the Social Science Citation Index (1988 to 2000; material published before 1988 could not be searched through Internet in this database). Various combinations of the following keywords were used: *job demands*, *control*, *suppor*t, *skill discretion*, *longitudina*l, *(job) DC/S model* and *job strain*. After retrieving the longitudinal studies located in this vein, we insptected the references to these studies to track down other longitudinal studies on the DC/S model that had not yet been included. Furthermore, several internationally acknowledged experts working with the DC/S model were contacted through email. They provided longitudinal studies for inclusion in our review as well.

In order to be included, studies had to meet the following criteria: (a) the study was based on two or more waves of data; (b) the study was based on the DC or DCS model; (c) the dimensions of the DC/S model were measured by questionnaire; (d) the study was published either before or in 2000. No restrictions were imposed regarding the type of outcome variable.

Table 2.1

Criteria for Evaluating the Quality of Longitudinal Research

Criteria	* 1 star (insufficient)	** 2 stars (sufficient)	*** 3 stars (good)	**** 4 stars (very good)
1 Design	At least one variable not measured on all occasions	At least one variable not measured on some occasions (incomplete panel design)	All variables measured twice (complete panel design)	All variables are measured more than twice (complete panel design with >2 measurements)
2 Time lags	1 time lag and no argument	> 1 and no argument	1 time lag and a theoretical and/or methodological argument	> 1 time lag and a theoretical and/or methodological argument
3 Measures	Insufficient or questionable information	Good references	Good references and good psychometric checks on own data	Good references and good psychometric checks upon own data and at least 1 “objective” indicator
4 Method of analysis	Correlational research	-	SEM (structural equation modeling) and/or multiple regression	-
5 Non-response analysis	No check on selectivity of the sample	Check on selective Time 1 response or check on selective panel or follow-up response	Check on selective Time 1 response *and* check upon selective panel or follow-up response	Check on selective Time 1 response and check on selective panel or follow-up response, and further research of the differences between the response and the nonresponse group concerning the hypotheses of the study

In this vein, 45 longitudinal studies on the DC/S model were identified (these 45 articles are included in the list of references to the present study, preceded by an aterisk study number). Note that some studies were based on partly the same data set (this applies to Bosma et al., 1997, Bosma, Peter, Siegrist, & Marmost, 1998; Carayon, 1992, 1993; Stansfeld, Fuhrer, Head, Ferrie, & Shipley, 1997; Stansfeld, Fuhrer, Shipley, & Marmot, 1999). As these studies were based on different end-points or different research questions (i.e., they presented different parts of the same underlying data set), they were evaluated separately.

Author ratings. All 45 studies were rated by de Lange using the rating scheme presented in Table 2.1. To obtain an impression of the reliability of this rating, we contacted the 39 first authors of the 45 studies by surface mail. Note that some authors published two or more relevant studies in which partly the same data set was analysed (e.g., the outcome variable differed across studies). These studies were considered independently. They received a letter explaining the aim of our study, our assessment of their study, an extended version of the rating scheme presented in Table 2.1, and an answer sheet. We felt that providing authors with our rating of their work might influence the response rate negatively. Therefore, they did not receive our judgment of their quality of their study but rather the *facts* reported in their study. For example, for "Number of measurements" we mentioned the number of waves of the study; for "Statistical analysis" the method of analysing the data was mentioned; and so on. The authors were asked whether they agreed with our judgment; if not, they were asked what they felt was correct, as well as why they felt that our judgment was incorrect.

After 2 months, 23 completed questionnaires (a 58.9% response rate) had been returned. Nonresponse analysis revealed that our ratings of the studies corresponding with these 23 authors (Table 2.4) did not differ significantly from our ratings of the studies authored by the nonresponders. Thus, there was no reason to assume that the response was biased. In 7 cases (30%) the authors fully agreed with our judgment. In the other cases authors either felt that our judgments were not (entirely) correct, or provided more information about their study. In all cases their comments were checked by the de Lange and Taris. As might be expected, the general purport of these reactions was that our ratings were too negative. One quite typical reaction was that we were correct in noting that a particular study did not report information about the reliability of the measures used, but

that the relevant information could be found in other publications or reports. If so (and if the reliability of these measures was acceptable), our ratings of these studies were amended accordingly.

The authors commented in 29 cases on our evaluation of particular aspects of their study. In seven cases, these comments led to a minor change in our rating. As each study was rated on 5 criteria, this figure implies that of the in total (23 x 5 =) 115 ratings that were checked by the authors, (100 - 29/115 =) 74.8% was accepted as correct.

2.4 Results

2.4.1 Description of the 45 studies

Table 2.2 presents information on the 45 longitudinal studies examining the DC/S model. This table presents detailed information concerning the homogeneity/heterogeneity of the population under study, the model tested (DC or DCS model), the measurement of the DC/S dimensions, the outcome type, and the type of confounders that was controlled (if any).

Population. The nature and size of a research population may have important implications for the results of a study (de Jonge & Kompier, 1997). Specifically, the research population should present enough variation on the DC/S dimensions. Kristensen (1995) even argues that the amount of variation is more important than the representativeness of the sample under study. As heterogeneous populations (i.e., populations including more than one job category) present more variation or exposure contrast in work characteristics than homogeneous populations (including participants with the same jobs), heterogeneous populations may be considered as more useful for testing the effects of (combinations of) job characteristics. Table 2.2 shows that 33 of the 45 studies selected for this review (73%) employed heterogeneous samples.

DC versus DC/S model. Contrary to earlier reviews (e.g., van der Doef & Maes, 1999), the studies selected in this review examined the DCS model more often than the DC model: 34 out of 45 studies (76%) used the DCS model.

Measurement of DC/S dimensions. Psychosocial work characteristics can be measured at the level of the individual participants (e.g., employing self report questionnaires) or at the job level (by imputing values for the job characteristics, Landsbergis & Theorell, 2000). In the latter strategy, occupation codes provided by the participants are used to estimate the levels of job demands, control and support that are typical for their jobs (e.g., based on expert judgments). Thus, all individuals in a particular occupation receive the same scores on the work characteristics; individual (error) variability between subjects is thus discarded, at the cost of discarding true individual and within-occupation variation in job characteristics as well. Table 2.2 shows that 6 of our 45 studies (13 %) used the imputation method. Almost half (53%) of the studies using self-report questionnaires employed Karasek et al.'s (1998) Job Content Questionnaire (JCQ) or JCQ-based items. In the remaining cases less well-known instruments were used.

Outcome type. The 45 studies selected for this review used many different outcome variables. These were grouped in six categories: (a) self-report measures for health and/or well-being, (b) sickness absence measures, (c) cardiovascular measures, (d) other physiological measures, (e) life style factors; and (f) other outcomes (such as “risk scores” based on different types of outcome variables, and externally determined psychotic disorders).

Table 2.2

Information on 45 selected longitudinal studies

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
1 Barnett & Brennan (1997)	He: 504 Full-time employed ♀, ♂(couples from 2 Boston-area towns)	DCS	Job Experience scale (Barnett & Brennan, 1995)	1 Psychological distress	A, B
2 Bosma et al. (1997)	He: 6895 ♂ (67%), 3413 ♀ (33%) civil servants aged from 20 London based civil service departments	DCS	JCQ	3 New cases of angina, severe pain across the chest, diagnosed ischaemic heart disease, any coronary event	A, B, D
3 Bosma et al. (1998)	He: 6895 ♂ (67%), 3413 ♀ (33%) civil servants aged from 20 London based civil service departments	DCS	JCQ	3 New cases of angina, severe pain across the chest, diagnosed ischaemic heart disease, any coronary event	A, B, D
4 Bourbonnais et al. (1999)	Ho: ♀ 1741 nurses in six hospitals in Quebec, Canada	DCS	JCQ	1 Psychological distress and burnout	A, B, D
5 Bromet et al. (1988)	He: 325 Non-managerial ♂employees of 2 nuclear power plants and 2 generating plants in Pennsylvania	DCS	- Occupational stress scales (House et al., 1979) - Social support measured (Moos, 1981)	5 Alcohol-related problems 6 Interview determined diagnosable episodes of depression, anxiety, symptoms, SCL-90	A, D
6 Carayon (1992)	He: 122 office workers (70% ♀, 30% ♂) from a midwestern public service organization	DCS (1992)	Scales from - Caplan et al. (1975), - Sanfort (1990), - Quinn et al. (1971)	1 Indicators of worker strain	A

Nb. More detailed information about these 45 studies can be obtained from the first author. **He**= Heterogeneous (when the study was based on >1 type of occupation; independent of the type of position within the occupation); **Ho**= Homogeneous (when the study was based on 1 type of occupation; position within the occupation not considered); Type of dependent measure: **1**) Self-report measures for health and/or well-being, **2**) Sickness absence measures, **3**) Cardiovascular measures, **4**) Other physiological measures, **5**) Life style factors, **6**) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders, etc.); Type of Confounder: A= Demographic variables (Age, Gender etc.), B= Personality characteristics (Hostility, Negative affectivity), C= Life style factors (such as smoking behaviour and alcohol consumption), D= Other factors (e.g. earlier health complaints, family history, relevant physiological control measures); JCQ= Job Content Questionnaire; DC= Demand-Control model; DCS= Demand-Control-Support model; GHQ= General Health Questionnaire; NHANES1= First National Health and Nutrition Examination Survey; ♀= women; ♂= men.

-Table 2.2 continued-

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
7 Carayon (1993)	He: 122 office workers (70% ♀, 30% ♂) from a midwestern public service organization	DC (1993)	Scales from: - Caplan et al. (1975), - Sanfort (1990), - Quinn et al. (1971)	1 Indicators of worker strain	A
8 Chapman et al. (1990)	He: 534 ♀, 2100 ♂ Australian government employees working in Sydney (♂ from 8 diverse occupations, ♀ from 2 occupations)	DCS	Work-response questionnaire (items from several sources : Eysenck, 1968 ; Ferguson, 1971 ; Jenkins et al., 1965 ; Moos, 1974)	3 Blood pressure	C, D
9 Cheng et al. (2000)	Ho: Ongoing cohort of 21290 registered ♀ nurses in US	DCS	JCQ	1 Indicators of subjective health	A, C, D
10 Crum et al. (1995)	He: 126 (72.2% ♂ and 27.8% ♀) incident cases, 381 Age- and Residence-related – Matched non-cases from household residents in five metropolitan areas (different occupations)	DCS	Imputation method (US Labor Force Surveys)	5 Alcohol abuse; determined in an interview; using data from Diagnostic Interview Schedule	A, D
11 Daniels & Guppy (1994)	Ho: 244 (86.1% ♂, 13.9% ♀) British accountants	DCS	Job / organisational characteristics, support and stressors scale (Dewe, 1989; Haywood-Farmer and Stuart, 1990; House, 1981)	1 Psychological well-being	D
12 van der Doef & Maes (2000)	Ho: 369 nurses (85% ♀, 15% ♂) from 7 nursing homes	DCS	Leiden Quality of Work questionnaire (van der Doef & Maes, 1999)	1 Psychological distress 6 Cardiovascular Risk Score: based on e.g. gender, age, smoking status, blood sample analysis of serum cholesterol	A, D

-Table 2.2 continued-

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
13 Dollard (1997)	Ho: 107 nurses (99 ♀, 8 ♂) employed in a medium sized public hospital in rural Australia	DCS	Work Environment Scale (Moos, 1986)	1 Indicators of health, work-home conflict and job satisfaction	A, B, C, D
14 van Egeren (1992)	He: 37 employees with sedentary jobs at the Michigan State University (20 ♀, 17 ♂; different occupations)	DC	JCQ	3 Blood pressure	A, B, D
15 Fenwick & Tausig (1994)	He: 830 American workers (29% ♀, 71% ♂; different occupations)	DCS	JCQ	1 Life satisfaction and indicators of stress: psycho-physiological symptoms associated with anxiety	A, D
16 Furda et al. (1994)	Ho: 115 Dutch employees (32.3% ♀, 67.7% ♂) working in an Insurance Company (administrative functions)	DCS	JCQ	1 Subjective health and recovery complaints	A
17 Hammar et al. (1998)	He: 10008 Swedish cases (8833 ♂, 1175 ♀) of first myocardial infarction and 28448 (24913 ♂, 3535 ♀) controls (different occupations)	DCS	Imputation method: Work organization exposure matrix (WOM; Johnson et al., 1996)	3 Myocardial infarction	A, D
18 Hjollund et al. (1998)	He: 430 (♀, ♂) couples (childless, wish for child; different occupations)	DCS	JCQ	4 Fertility	A, D
19 Johnson et al. (1995)	Ho: 495 (♀, ♂) graduates, working as physician	DCS	JCQ (adapted to physicians)	1 Indicators of psychiatric distress, Job dissatisfaction	A

-Table 2.2 continued-

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
20 Johnson et al. (1989)	He: 7219 ♂ employed Swedish (blue, white-collar workers, different occupations)	DCS	Swedish questionnaire measuring items relating to work (Johnson, 1986; Johnson & Hall, 1988; Johnson, 1989)	3 The prevalence of CVD morbidity and cardiovascular-specific mortality	A
21 Johnson & Stewart (1993)	He: 12084 employed Swedish citizens (46.8% ♀, 53.2% ♂)	DCS	Scales and imputation method (job exposure matrix; Hall, 1992; Johnson et al., 1990)	1 Subjective health: 1 or more subset of illnesses with a plausible stress-related etiology	A, D
22 de Jonge et al. (1998)	Ho: 261 (87% ♀, 13% ♂) nurses and caregivers	DCS	-Maastricht Autonomy Questionnaire (de Jonge et al., 1994) -Work pressure scale (de Jonge et al., 1993) -Social support scale (VOS-D, Bergers et al., 1986)	1 Burnout and job satisfaction	-
23 Karasek (1979)	He: 950 Swedish employed ♂	DCS	JCQ	1 Indicators of mental strain	A, D
24 Karasek et al. (1981)	He: 1461 Swedish employed ♂	DCS	JCQ	3 Cardiovascular disease	A, C, D

-Table 2.2 continued-

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
25 Kivimäki et al. (2000)	He: 764 (189 ♂, 575 ♀) Finnish municipal employees who remained in employment after downsizing (blue- and white-collar workers; different occupations)	DCS	Items based on JCQ	2 Certified sickness absence	A, C, D
26 Landsbergis & Hatch (1996)	He: 717 ♀ workers (from Pennsylvania and New York; predominantly middle class; different occupations)	DCS	11 questions on psychosocial characteristics (comparable with JCQ; items in Appendix of article)	3 Pregnancy Induced Hypertension	A, D
27 Landsbergis et al. (1998)	He: 202 employed American ♂ (different occupations)	DC	JCQ	5 Cardiovascular disease-related health behaviours: e.g. cigarette smoking, alcohol use, lack of exercise	A, D
28 Muntaner et al. (1991)	He: 11789 (♂, ♀) American household residents (blue- and white-collar workers; 2 different occupations)	DCS	Imputation method (based on 3 national surveys on employment conditions conducted by the Department of Labor (Schwartz et al. (1988))	6 Psychotic disorders diagnosed by interviewers	A, C, D
29 Noor (1995)	He: 180 English ♀ working who were solicited from 2 occupational groups	DC	Work overload and autonomy scales (Baruch & Barnett, 1986)	1 Measure of positive affect (Happiness) and of psychological distress (GHQ)	A, B, D

-Table 2.2 continued-

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
30 Parkes (1982)	Ho: 164 student nurses (♂, ♀) British or Irish)	DCS	-Questionnaire based on DC model (Karasek, 1979) -Work environment scale (Moos, 1981)	1 Indicators of Psychological distress: somatic symptoms depression, anxiety social dysfunction, work satisfaction 2 Non-certificated sickness absence spells	A, D
31 Parkes (1991)	Ho: 264 (93 ♂, 171 ♀) graduates taking a 1 year course leading to a teaching qualification	DC	Questionnaire based on JCQ	1 Indicators of mental health: anxiety, social dysfunction	A
32 Parkes et al. (1994)	Ho: 264 (93 ♂, 171 ♀) graduates taking a 1 year course leading to a teaching qualification	DCS	Questionnaire based on JCQ	1 Indicators of somatic symptoms	A, B
33 Pollard et al. (1996)	He: 104 workers (51 ♂, 53 ♀; recruited from the general population (different occupations)	DC	Scales from Warr (1990)	1 Indicator of mood 4 Hormones	C, D
34 Reed et al. (1989)	He: 8006 ♂ of Japanese ancestry in Hawaii (different occupations)	DC	Imputation method (using occupation scores of the 1970 US Census Occupation; Schwartz et al., 1988)	3 Incidence of coronary heart disease	A, C, D
35 Riese et al. (2000)	Ho: 165 ♀ nurses (from 3 non-academic hospitals in Amsterdam, the Netherlands)	DCS	JCQ	3 Risk indicators of cardiovascular disease	A, C, D

-Table 2.2 continued-

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
36 Schnall et al. (1998)	He: 195 American ♂(different occupations, white-collar workers over-represented)	DC	JCQ	3 Ambulatory blood pressure	A, B, C, D
37 Smulders & Nijhuis (1999)	He: 1755 ♂ employees of a technical maintenance firm in the public sector (the Netherlands)	DC	Questionnaire measuring psychosocial characteristics (Smulders & Nijhuis, 1999)	2 Registered sickness absence rate and frequency	A, D
38 Stansfeld et al. (1998)	He: 10308 British (♀, ♂) civil servants	DCS	-JCQ -Social Support: Close Persons Questionnaire (Berkman & Syme, 1979)	1 Indicators of physical, emotional and social functioning	A, B, C, D
39 Stansfeld et al. (1997)	He: 6895 ♂ and 4313 ♀ (11208) London-based civil servants	DCS	-JCQ	1 Indicators of Psychological distress (GHQ) 2 Computerized sickness absence records	A,C, D
40 Stansfeld et al. (1999)	He: 6895 ♂ and 4313 ♀ (11208) London-based civil servants	DCS	-JCQ	1 Indicators of Psychological distress (GHQ)	A, D
41 Steenland et al. (1997)	He: 3575 ♂ and 519 heart disease cases (NHANES1; blue- and white-collar workers; different occupations)	DC	Imputation method (1970 US Census Coding)	3 Heart disease	A, C, D

-Table 2.2 continued-

Study	Population	DC or DCS model	Measurement of DC/S	Outcome type	Type of confounder
42 Steptoe et al. (1998)	He: 71 workers (44 ♀, 27 ♂) in the retail industry (mostly working in sales departments, some in distribution)	DCS	-JCQ -Scale from Frankenhaeuser et al. (1989)	1 Indicators of well-being, job satisfaction and work-home interference 4 Cortisol 5 Smoking and alcohol consumption	A, C
43 Theorell et al. (1990)	He: 44 working ♂ from 6 different occupations (blue- and white-collar workers)	DC	-Items based on JCQ	4 Plasma testosterone fluctuations	A, C, D
44 Vahtera et al. (2000)	He: 530 municipal Finnish workers (138 ♂, 392 ♀; blue- and white-collar workers; different occupations))	DCS	-Items based on JCQ	2 Medically certified sickness absence rates	A, C, D
45 Vahtera et al. (1996)	He: 856 (♀, ♂) Finnish municipal employees (blue- and white-collar workers; different occupations)	DCS	-Items based on JCQ (Questions from 2 Finnish studies: Lehto (1991) and Kalimo et al. (1993)	2 Medically certified sickness absence spells	A, D

Nb. More detailed information about these 45 studies can be obtained from the first author. **He**= Heterogeneous (when the study was based on >1 type of occupation; independent of the type of position within the occupation); **Ho**= Homogeneous (when the study was based on 1 type of occupation; position within the occupation not considered); Type of dependent measure: **1**) Self-report measures for health and/or well-being, **2**) Sickness absence measures, **3**) Cardiovascular measures, **4**) Other physiological measures, **5**) Life style factors, **6**) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders, etc.); Type of Confounder: A= Demographic variables (Age, Gender etc.), B= Personality characteristics (Hostility, Negative affectivity), C= Life style factors (such as smoking behaviour and alcohol consumption), D= Other factors (e.g. earlier health complaints, family history, relevant physiological control measures); JCQ= Job Content Questionnaire; DC= Demand-Control model; DCS= Demand-Control-Support model; GHQ= General Health Questionnaire; NHANES1= First National Health and Nutrition Examination Survey; ♀= women; ♂= men.

Table 2.2 shows that the majority of the studies (51%, 23 studies) examined self-report measures for health or well-being (mostly indicators of psychological distress). In addition, 6 studies (13%) examined sickness absence, 12 studies (27%) examined indicators of cardiovascular disease, 4 studies (9%) focused on other physiological strain-related measures, 4 studies (9%) examined life style factors, and 3 studies (7%) examined other outcome measures such as externally determined psychotic disorders. Note that these percentages do not add up to 100%, as studies could explore more than one type of outcome.

Confounders. Generally speaking, in determining the causal relationship between work and health it is important to control for alternative explanations (especially when examining categorical outcomes; see Schnall et al., 1994). Table 2.2 shows that the studies included in this review controlled for various types of possible confounders, mostly for (a) demographic variables (age, gender and the like; these were controlled for in 41 studies); but also for (b) personality characteristics (e.g., hostility, negative affectivity; these were controlled in 10 studies); (c) life style factors (such as smoking behaviour and alcohol consumption; these were controlled for in 16 studies); and (d) other factors (earlier health complaints, family history, relevant physiological control measures; these were controlled for in 35 studies).

Related to outcome type, Table 2.2 shows that the 45 studies did not consistently control for the same number and type of confounders. For instance, of the 23 studies examining self-report measures for health and well-being, most (20 studies) controlled for demographic variables, but some studies also controlled for personality characteristics (6 studies), life style factors (6 studies) and other factors (13 studies). The same applies to the 12 studies examining cardiovascular measures, of which most studies (11 studies) controlled for demographic variables, but some studies also controlled for personality characteristics (4 studies), life style factors (6 studies) and other factors (10 studies).

Although it is generally desirable to control for possible confounders, it is for several reasons unclear how inclusion of various types of control variables should be evaluated in this review. First, it would seem that in some cases the distinction between control variable and variable of substantive interest is blurred. For instance, the cluster of life style factors

includes control variables that may equally well serve as outcomes, next to the variables of interest in these studies (such as alcohol-related problems). Second, it is often hard to decide whether inclusion of a specific control variable is necessary to obtain an unbiased estimate of a particular effect. Whether a researcher should control for a particular variable depends strongly of the process under study -- but as the precise nature of this process is often largely unknown, it is also difficult to decide *which* variables should be controlled for. Inclusion of control variables is not a matter that should be taken lightheartedly; e.g., while some authors recommend to control for differences in negative affectivity as a matter of routine, others strongly argue against inclusion of this concept as this would lead to an underestimation of the magnitude of the effects of interest (Karasek et al., 1998; Spector, Zapf, Chen & Frese, 2000). Thus, "better safe than sorry" does not apply here. Finally, it is often argued that the bias resulting from confounders is relatively limited in longitudinal research, as participants act as their own controls (Taris, 2000). If this is true, there is no reason to discount studies because they do not include any control variables. For these reasons we decided not to judge the methodological quality of the 45 studies included in the present research in terms of the presence versus the absence of control variables.

2.4.2 Evaluation of the quality of the 45 studies

Table 2.3 presents our evaluation of the 45 studies on the basis of the evaluation criteria shown in Table 2.1. The number of stars per criterion varied across studies, except for Method of analysis.

Design. One study (Riese, van Doornen, Houtman & De Geus, 2000) was evaluated as “insufficient”, because it did not measure the dependent and independent variable at the same point in time. As a result, cross-lagged effects could not be examined. In 19 studies (42%) an incomplete panel design was used, as some of the research variables were not measured at all occasions: therefore, these studies were rated as *sufficient*. A complete panel design was used in 25 studies (53%). Sixteen of these included two measurements (these were evaluated as *good*), whereas 9 studies included more than two measurements (*very good*).

Table 2.3

Evaluation of 45 longitudinal studies on the DC/S Model

Study		Number of measurements	Design	Time lags	Measures	Non-response analysis
1[a]	Barnett & Brennan (1997)	3	****	**	**	**
2[a]	Bosma et al. (1997)	3	****	**	****	***
3[a]	Bosma et al. (1998)	3	****	**	****	***
4[a]	Bourbonnais et al. (1999)	2	***	**	***	****
5[a]	Bromet et al. (1988)	2	**	**	**	***
6[a]	Carayon (1992)	2	***	**	***	**
7[a]	Carayon (1993)	2	***	**	***	***
8[a]	Chapman et al. (1990)	3	****	**	**	**
9	Cheng et al. (2000)	2	***	*	**	**
10	Crum et al. (1995)	2	**	*	**	***
11[a]	Daniels & Guppy (1994)	2	**	***	***	***
12	van der Doef & Maes (2000)	2	***	**	****	*
13[a]	Dollard (1997)	2	**	**	****	****
14	van Egeren (1992)	4	**	**	**	*
15	Fenwick & Tausig (1994)	2	***	*	**	**
16	Furda et al. (1994)	2	***	*	***	*
17	Hammar et al. (1998)	2	***	*	**	**
18[a]	Hjollund et al. (1998)	6	**	****	**	**
19[a]	Johnson et al. (1995)	2	**	**	***	**
20	Johnson et al. (1989)	2	***	*	**	*
21	Johnson & Stewart (1993)	2	**	*	**	**
22[a]	de Jonge et al. (1998)	2	***	***	**	**
23	Karasek (1979)	2	***	*	***	**
24	Karasek et al. (1981)	2	***	*	**	**
25	Kivimäki et al. (2000)	3	**	****	****	*

Note. * = insufficient, ** = sufficient, *** = good, **** = very good; The results for method of analysis are not included as all studies were evaluated as "good"; [a]= These studies were judged as at least "sufficient" on all 5 criteria, and were thus considered high-quality studies.

-Table 2.3 continued-

Study	Number of measurements	Design	Time lags	Measures	Non-response analysis
26[a] Landsbergis & Hatch (1996)	3	**	**	****	**
27 Landsbergis et al. (1998)	2	***	*	****	**
28 Muntaner et al. (1991)	2	**	*	**	*
29 Noor (1995)	2	***	*	**	*
30[a] Parkes (1982)	5	**	**	****	**
31[a] Parkes (1991),	3	**	**	***	***
32[a] Parkes et al. (1994)	2	**	**	***	***
33 Pollard et al. (1996)	3	****	****	****	*
34 Reed et al. (1989)	3	**	**	**	*
35 Riese et al. (2000)	2	*	*	**	**
36 Schnall et al. (1998)	2	***	*	****	**
37 Smulders & Nijhuis (1999)	4	**	**	****	*
38 Stansfeld et al. (1998)	3	****	**	***	*
39 Stansfeld et al. (1997)	3	****	**	**	*
40 Stansfeld et al. (1999)	3	****	**	***	*
41 Steenland et al. (1997)	2	**	*	**	*
42[a] Steptoe et al. (1998)	4	**	**	****	**
43 Theorell et al. (1990)	4	****	****	****	*
44[a] Vahtera et al. (2000)	3	**	****	****	**
45 Vahtera et al. (1996)	2	***	*	****	**

Note. * = insufficient, ** = sufficient, *** = good, **** = very good; The results for method of analysis are not included as all studies were evaluated as "good"; [a]= These studies were judged as at least "sufficient" on all 5 criteria, and were thus considered high-quality studies.

Time lags. Table 2.3 shows that 26 studies used a two-wave design, whereas 19 studies included three to six measurements. The time lags between the measurements of all 45 studies varied between approximately 28 days (Hjollund et al., 1998, Study 18) to 12 years (Steenland, Johnson, & Nowlin, 1997, Study 41). Seventeen of these 45 studies (38%) failed to present a theoretical or methodological argument for the time lag used. These

studies were rated as *insufficient* on this criterion. Fifteen studies employed more than two measurements and were evaluated as *sufficient*. Two 2-wave studies provided a satisfactory argument for their time lags used and were evaluated as *good*. Daniels and Guppy (1994) used a 1-month time lag, based on earlier research examining the relationship between social support and control. De Jonge et al. (1998) used a 1-year time lag to measure indicators of psychological distress based on the results of a pilot study that recommended this time lag to control for seasonal effects. Six other two-wave studies also used a 1-year time lag to predict effects of the DC/S dimensions on psychological distress (Bourbonnais et al., 1999; Bromet et al., 1988; Carayon, 1992; 1993; Dollard, 1997; Johnson et al., 1995), but these failed to provide an argument for this particular lag and were therefore revalued as *sufficien*t (instead of *insufficient*).

Five multi-wave studies (Hjollund et al., 1998; Kivimäki, Vahtera, Pentti, & Ferrie, 2000; Pollard, Ungpakorn, Harrison, & Parkes, 1996; Theorell, Karasek, & Eneroth, 1990; Vahtera, Kivimäki, Pentti, & Theorell, 2000) were rated as *very good*. Hjollund et al. (1998) examined the relationship between high demands, low control and fertility of women and measured these variables on two to six occasions. Their time lag was based on the length of the menstrual cycle (with a maximum of six cycles), and may thus vary between and within participants. The three-wave studies by Kivimäki et al. (2000) and Vahtera et al. (2000) addressed the effects of downsizing on employee health. The time lags of 3 and 2 years (Kivimäki et al., 2000) and 3 and 4 years (Vahtera et al., 2000) were based on the timing of the organisational interventions: the questionnaires were sent out before, during and after downsizing. Pollard et al. (1996) examined the effects of the DC dimensions on epinephrine and cortisol levels over time, using two 1-day time lags to compare working days with rest days (Sunday). Further, they based the time lag for measuring hormones on results of earlier research that showed that urinary excretion rates of epinephrine reflects plasma levels within 1 hour. Theorell et al. (1990) examined the relationship between DC dimensions and plasma testosterone fluctuations over time. They used three 3-month periods between their measurements, arguing that this time lag avoids group effects as a result of seasonal variation.

Measures used. No studies were considered *insufficient* on this criterion. Nineteen studies (42%) presented good references for their measures, but did not provide psychometric checks or provided unsatisfactory results for their measures (e.g., Cronbach's

alphas < .70). They were therefore evaluated as *sufficient*. Eleven studies (24%) presented both good references for the measures used and acceptable psychometric checks. These studies were rated as "good". Finally, 15 studies (33%) not only presented good references and psychometric checks, but included an objectively measured indicator as well. These studies were evaluated as "very good".

Method of analysis. Little variation was found on this criterion: all studies were evaluated as "good". Multiple regression analysis was used in 43 studies: two studies (Barnett & Brennan, 1997; Fenwick & Tausig, 1994) employed SEM.

Nonresponse analysis. Fifteen studies (33%) did not sufficiently examine possible response bias on the first and the follow-up measurements. Twenty studies (44%) examined possible response bias on at least one of the measurements of the study (the first or follow-up). Eight studies (18%) were evaluated as "good", because they explored the selectivity of the response on the first measurement as well as on the follow-up wave. Bourbonnais et al. (1999) and Dollard (1997) were evaluated as "very good", because these studies presented an elaborate discussion of possible selective response and drop-out.

2.4.3 High-quality studies and their results

What are the high-quality studies? Our first research question concerned the identification of high-quality longitudinal studies. The 45 studies were divided in two categories using what might be called a "multiple-hurdle" approach (with the hurdles corresponding with the five evaluation criteria). To be considered a *high-quality* study, studies had to obtain at least *sufficient* scores on all five criteria (19 studies, 42%). This procedure is based on the reasoning that the magnitude of the effects presented in the less reliable studies might be over- or underestimated as a result of different forms of bias. Thus, this procedure maximizes the reliability of the results presented in the high-quality studies.

What are the results of the high-quality studies? Table 2.4 presents a detailed breakdown of the findings reported in the 19 high-quality studies. The results of these studies are first discussed per type of outcome variable. Next, we discuss whether the results provide support for the strain hypothesis of the DC or DCS model. Following Greenland (1998), if a study reports significant main effects of demands and control as well as a demand x control interaction effect, we will only interpret the interaction effect.

Further, as this study focuses on the effects of the dimensions of the DC/S model, Table 2.4 does not present possible interactions with other variables.

Self-report measures for health and/or well-being. Twelve high-quality studies (63%) examined self-report measures for health and/or well-being (mostly indicators of psychological distress). Three of these (Barnett & Brennan, 1997; Bourbonnais et al., 1999; Parkes, 1982) reported main effects of both demands and control in predicting indicators of psychological well-being over time (confirming the strain hypothesis of the DC model). Next to main effects of demands and control, Bourbonnais et al. (1999) and Parkes (1982) reported main effects of social support in predicting the outcome variables as well.

Parkes, Mendham, and von Rabenau (1994) and Dollard (1997) reported significant multiplicative demand x control interaction effects in predicting somatic symptoms and job satisfaction across time, respectively. For the other outcomes in Dollard's (1997) study (physical health complaints and work-home conflict) no main or interaction effects were found. Further, Steptoe et al. (1998) found a significant effect of across-time difference scores for demands and control and a main effect of social support in predicting job satisfaction. No effects were found for perceived stress and psychological well-being. Thus, 6 of the 12 high-quality studies reported significant joint effects of the DC/S dimensions in predicting indicators of subjective well-being.

Apart from evidence for joint effects, 7 of the 12 studies (58%) presented evidence for (a) main effect(s) of the DC/S dimension(s) (i.e., no combined effects of DC/S dimensions in line with the strain hypothesis of DC/S model) and evidence for other effects of (combinations of) demands, control and support in predicting self-report measures for health and/or well-being. In six instances (Carayon, 1992, 1993; Daniels & Guppy, 1994; de Jonge et al., 1998; Parkes et al., 1991; Steptoe et al., 1998) a main effect of demands was reported. Main effects of social support were reported by Carayon (1992), Daniels and Guppy (1994), Johnson et al. (1995), and de Jonge et al. (1998). Finally, Johnson et al. (1995) and de Jonge et al. (1998) reported main effects of control.

Sickness absence. Two high-quality studies (11%) measured sickness absence (Parkes, 1982; Vahtera et al., 2000). The study by Parkes (1982) revealed a main effect of demands in predicting (non-certified) sickness absence spells, whereas Vahtera et al. (2000) found interaction effects of demands and social support, and control and social support in predicting (medically certified) sickness absence rates.

Cardiovascular measures. Four studies (21%; Bosma et al., 1997; Bosma et al., 1998; Chapman et al., 1990; Landsbergis & Hatch, 1996) examined indicators of cardiovascular disease. None of these studies reported significant joint effects of job demands and control, at least not in the expected direction (cf. Chapman et al., 1990). Bosma et al. (1997, 1998) found significant effects of control in predicting indicators of cardiovascular disease, whereas Landsbergis and Hatch (1996) found no significant effects of the DC/S dimensions at all in their overall sample.

Other physiological measures. Two high-quality studies (11%; Hjollund et al., 1998; Steptoe et al., 1998) examined other physiological variables. Hjollund et al. (1998) reported no joint effects in predicting fertility, at least not for their total sample. Steptoe et al. (1998) found significant effects of across-time difference scores for demands and control in predicting cortisol levels, but this effect was not in line with the strain hypothesis of the DC model.

Life style factors. Two studies (11%; Bromet et al., 1988; Steptoe et al., 1998) measured life style factors. Bromet et al. (1988) reported a multiplicative DC interaction effect in predicting alcohol-related problems. The study of Steptoe et al. (1998) revealed a significant main effect of social support in predicting alcohol consumption.

Table 2.4

Overview of the results of 19 high-quality studies

Study	Population	Dependent variable(s)	Effects of DC/S dimensions	Support strain hypothesis DC and/or DCS model	Time lag(s)	Evidence causation
1 Barnett & Brennan (1997)	**He**: 504 Full-time employed ♀, ♂(couples from 2 Boston-area towns)	1 Psychological distress	D^s, C^s ("skill discretion"), (S)	DC	2 of 1 year (**)	A: + B: n.e.
2 Bosma et al. (1997)	**He**: 6895 ♂ (67%), 3413 ♀ (33%) civil servants aged from 20 London based civil service departments	3 New cases of angina, severe pain across the chest, diagnosed ischaemic heart disease, any coronary event	(D), C^s, (S)	X	2 of which mean length of follow-up: 5.3 years (**)	A: + B: n.e.
3 Bosma et al. (1998)	**He**: 6895 ♂ (67%), 3413 ♀ (33%) civil servants aged from 20 London based civil service departments	3 New cases of angina, severe pain across the chest, diagnosed ischaemic heart disease, any coronary event	(D), C^s, (S)	X	2 of which mean length of follow-up: 5.3 years (**)	A: + B: n.e.
4 Bourbonnais et al. (1999)	**Ho**: ♀ 1741 nurses in six hospitals in Quebec, Canada	1 Psychological distress and burnout -Psychological distress -Burnout	 D^s, C^s, S^s D^s, C^s, S^s	DC, DCS	1 of approximately 1 year (**)	A: + B: n.e.

Note. D = Demands; C = Control; S = Social support; D^s: effect of job demands is significant; (D) = effect of job demands is not significant at $p < .05$; DxC^s: interaction effect between job demands and job control is significant; D-C = difference score used to indicate job strain; * = insufficient; ** = sufficient; *** = good; **** = very good; A = "normal" causation; B = "reversed" or "reciprocal" causation; n.e. = not explored; + = evidence for causal relationship; X = no evidence; (-) = results not in line with strain hypothesis of DC/S model or no causal effects found; (#) = some effects were found in subgroup analyses, not reported here; 1) Self-report measures for health and/or well-being, 2) Sickness absence measures, 3) Cardiovascular measures, 4) Other physiological measures, 5) Life style factors, 6) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders).

-Table 2.4 continued-

Study	Population	Dependent variable(s)	Effects of DC/S dimensions	Support strain hypothesis DC and/or DCS model	Time lag(s)	Evidence causation
5 Bromet et al. (1988)	**He**: 325 Non-managerial ♂employees of 2 nuclear power plants and 2 generating plants in Pennsylvania	5 Alcohol-related problems	(D), C ^{s}, (S), DxC ^{s}	DC	1 time lag of 1 year (**)	A: + B: n.e.
		6 Interview determined: -Diagnosable episodes of depression, anxiety	D ^{s}, (C), (S) (DxC), DxS ^{s}			
		-Symptoms (SCL-90)	(D), (C), (S), DxC ^{s} (-)			
6 Carayon (1992)	**He**: 122 office workers (70% ♀, 30% ♂) from a midwestern public service organization	1 (Indicators of worker strain: stable over time; after controlling for earlier health):		X	1 time lag of 1 year (**)	A: + B: -
		-Boredom	(D), (C), (S)			
		-Workload dissatisfaction	D ^{s}, (C), S ^{s}			
		-Physical health complaints	D ^{s}, (C), (S)			

Note. D = Demands; C = Control; S = Social support; D ^{s}: effect of job demands is significant; (D) = effect of job demands is not significant at $p < .05$; DxC ^{s}: interaction effect between job demands and job control is significant; D-C = difference score used to indicate job strain; * = insufficient; ** = sufficient; *** = good; **** = very good; A = "normal" causation; B = "reversed" or "reciprocal" causation; n.e. = not explored; + = evidence for causal relationship; X = no evidence; (-) = results not in line with strain hypothesis of DC/S model or no causal effects found; (#) = some effects were found in subgroup analyses, not reported here; 1) Self-report measures for health and/or well-being, 2) Sickness absence measures, 3) Cardiovascular measures, 4) Other physiological measures, 5) Life style factors, 6) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders). [1] Detailed information about the ratings of the high-quality studies can be obtained from the first author

-Table 2.4 continued-

Study	Population	Dependent variable(s)	Effects of DC/S dimensions	Support strain hypothesis DC and/or DCS model	Time lag(s)	Evidence causation
7 Carayon (1993)	**He**: 122 office workers (70% ♀, 30% ♂) from a midwestern public service organization	1 (Indicators of worker strain: stable over time; after controlling for earlier health): -Daily life stress -Physical health complaints	 (D), (C) D ^{s}, (C)	X	1 time lag of 1 year (**)	A: + B: -
8 Chapman et al. (1990)	**He**: 534 ♀, 2100 ♂ Australian government employees working in Sydney (♂ from 8 diverse occupations, ♀ from 2 occupations)	3 Blood pressure	(D), (C), (S), DxC ^{s} (-)	X	2 of three and two years (**)	A: - B: n.e.
11 Daniels & Guppy (1994)	**Ho**: 244 (86.1% ♂, 13.9% ♀) British accountants	1 Psychological well-being	D ^{s}, (C), S ^{s}, (DxC)	X	1 of 1 month (***)	A: + B: n.e.
13 Dollard (1997)	**He**: 104 workers (51 ♂, 53 ♀; recruited from the general population (different occupations)	1 -Physical health symptoms -Work-home conflict -Job satisfaction	 (D), (C), (S), (DxC) (D), (C), (S), (DxC) (D), (C), S ^{s}, DxC ^{s}	DC, DCS	1 time lag of 1 year (**)	A: + B: n.e.

Note. D = Demands; C = Control; S = Social support; D ^{s}: effect of job demands is significant; (D) = effect of job demands is not significant at $p < .05$; DxC ^{s}: interaction effect between job demands and job control is significant; D-C = difference score used to indicate job strain; * = insufficient; ** = sufficient; *** = good; **** = very good; A = "normal" causation; B = "reversed" or "reciprocal" causation; n.e. = not explored; + = evidence for causal relationship; X = no evidence; (-) = results not in line with strain hypothesis of DC/S model or no causal effects found; (#) = some effects were found in subgroup analyses, not reported here; 1) Self-report measures for health and/or well-being, 2) Sickness absence measures, 3) Cardiovascular measures, 4) Other physiological measures, 5) Life style factors, 6) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders).

-Table 2.4 continued-

Study	Population	Dependent variable(s)	Effects of DC/S dimensions	Support strain hypothesis DC and/or DCS model	Time lag(s)	Evidence causation
18 Hjollund et al. (1998)	**He**: 430 (♀, ♂) couples (childless, wish for child; different occupations)	4 Fertility	(D), (C), (S) (#)	X	At least 5 of 28 days; for determining spontaneous abortion: 1 year after the measures (****)	A: X B: n.e.
19 Johnson et al. (1995)	**Ho**: 495 (♀, ♂) graduates, working as physician	1 -Psychiatric distress -Job dissatisfaction	 (D), C ^{s}, S ^{s} (D), C ^{s}, S ^{s}	X	1 time lag of 1 year	A: + B: n.e.
22 de Jonge et al. (1998)	**Ho**: 261 (87% ♀, 13% ♂) nurses and caregivers	1 Burnout and job satisfaction -Emotional Exhaustion -Depersonalization -Reduced personal efficacy -Job satisfaction	 D ^{s}, (C), S ^{s} D ^{s}, (C), S ^{s} (D), (C), S ^{s} (D), C ^{s}, S ^{s}	X	1 of 1 year (***)	A:+ B: n.e.
26 Landsbergis & Hatch (1996)	**He**: 717 ♀ workers (from Pennsylvania and New York; predominantly middle class; different occupations)	3 Pregnancy Induced Hypertension	(D), (C) (#)	X	2 of 15 and 8 weeks (**)	A: X B: n.e.

Note. D = Demands; C = Control; S = Social support; D ^{s}: effect of job demands is significant; (D) = effect of job demands is not significant at $p < .05$; DxC ^{s}: interaction effect between job demands and job control is significant; D-C = difference score used to indicate job strain; * = insufficient; ** = sufficient; *** = good; **** = very good; A = "normal" causation; B = "reversed" or "reciprocal" causation; n.e. = not explored; + = evidence for causal relationship; X = no evidence; (-) = results not in line with strain hypothesis of DC/S model or no causal effects found; (#) = some effects were found in subgroup analyses, not reported here; 1) Self-report measures for health and/or well-being, 2) Sickness absence measures, 3) Cardiovascular measures, 4) Other physiological measures, 5) Life style factors, 6) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders).

-Table 2.4 continued-

Study	Population	Dependent variable(s)	Effects of DC/S dimensions	Support strain hypothesis DC and/or DCS model	Time lag(s)	Evidence causation
30 Parkes (1982)	**Ho**: 164 student nurses (♂, ♀) British or Irish)	1 Indicators of Psychological distress		DC, DCS	4 of each approximately 6/7 weeks (**)	A: + B: n.e.
		-Somatic symptoms	(D), (C), (S)			
		-Depression	(D), C^{s}, S^{s}			
		-Anxiety	(D), C^{s}, S^{s}			
		-Social dysfunction	D^{s}, C^{s}, S^{s}			
		-Work satisfaction	(D), C^{s}, S^{s}			
		2 Sickness absence - Non-certificated Sickness/Absence (time)	D^{s}, (C), (S)			
31 Parkes et al. (1991)	**Ho**: 264 (93 ♂, 171 ♀) graduates taking a 1 year course leading to a teaching qualification	1991: 1 indicators of mental health		X	2 of 2 and 3/4 months (**)	A: + B: n.e.
		-Anxiety	D^{s}, (C)			
		-Social dysfunction	(D), (C)			
32 Parkes et al. (1994)	**Ho**: 264 (93 ♂, 171 ♀) graduates taking a 1 year course leading to a teaching qualification	1 indicators of somatic symptoms	D^{s}, (C), (S), $DxCxS^{s}$	DCS	1 of 2 months (**)	A: + B: n.e.

Note. D = Demands; C = Control; S = Social support; D^{s}: effect of job demands is significant; (D) = effect of job demands is not significant at $p < .05$; DxC^{s}: interaction effect between job demands and job control is significant; D-C = difference score used to indicate job strain; * = insufficient; ** = sufficient; *** = good; **** = very good; A = "normal" causation; B = "reversed" or "reciprocal" causation; n.e. = not explored; + = evidence for causal relationship; X = no evidence; (-) = results not in line with strain hypothesis of DC/S model or no causal effects found; (#) = some effects were found in subgroup analyses, not reported here; 1) Self-report measures for health and/or well-being, 2) Sickness absence measures, 3) Cardiovascular measures, 4) Other physiological measures, 5) Life style factors, 6) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders).

-Table 2.4 continued-

Study	Population	Dependent variable(s)	Effects of DC/S dimensions	Support strain hypothesis DC and/or DCS model	Time lag(s)	Evidence causation
42 Steptoe et al. (1998)	**He**: 71 workers (44 ♀, 27 ♂) in the retail industry (mostly working in sales departments, some in distribution)	1 Indicators of well-being, job satisfaction and work-home interference		DC, DCS	3: 2 of 1 month and 1 of 2 months (**)	A: + B: n.e.
		-Work- and home interference	D ^{s}, (C), (S)			
		-Job satisfaction	D-C ^{s}, S ^{s}			
		-Perceived stress	(D), (C), (S)			
		-Psychological well-being	(D), (C), (S)			
		4 Cortisol	D-C ^{s} (-), (S)			
		5 Smoking and Alcohol consumption:				
		-Smoking Behaviour	(D), (C), (S)			
		-Alcohol Consumption	(D), (C), S ^{s}			
44 Vahtera et al. (2000)	**He**: 530 municipal Finnish workers (138 ♂, 392 ♀; blue- and white-collar workers; different occupations)	2 Medically certified sickness absence rates	D ^{s}, C ^{s} (decision authority only), S ^{s}, DxS ^{s}, CxS ^{s}	DC, DCS	2: 3 and 4 years (****)	A:+ B: n.e.

Note. D = Demands; C = Control; S = Social support; D ^{s}: effect of job demands is significant; (D) = effect of job demands is not significant at $p < .05$; DxC ^{s}: interaction effect between job demands and job control is significant; D-C = difference score used to indicate job strain; * = insufficient; ** = sufficient; *** = good; **** = very good; A = "normal" causation; B = "reversed" or "reciprocal" causation; n.e. = not explored; + = evidence for causal relationship; X = no evidence; (-) = results not in line with strain hypothesis of DC/S model or no causal effects found; (#) = some effects were found in subgroup analyses, not reported here; 1) Self-report measures for health and/or well-being, 2) Sickness absence measures, 3) Cardiovascular measures, 4) Other physiological measures, 5) Life style factors, 6) Other measures (such as risk score based on different types of dependent outcomes; externally determined psychotic disorders).

Other outcomes. Bromet et al.'s (1988) study measured externally determined episodes of depression, anxiety and somatic symptoms. They found a significant DC interaction effect in predicting somatic symptoms, but this interaction was not in line with the DC model. For two other outcomes (depression and anxiety, as determined by experts in an interview) Bromet and his coworkers reported significant multiplicative interaction effects between demands and social support.

Support for the strain hypothesis of the DC/S model? Table 2.4 shows that three high-quality studies (Carayon, 1993; Landsbergis & Hatch, 1996; Parkes et al., 1991) explored the *DC* model, whereas the 16 other high-quality studies examined the *DCS* model. These 16 studies may provide support for the strain hypothesis of both the DC and/or the DCS model.

Table 2.4 shows that the three high-quality studies examining the DC model provided no support for the strain hypothesis. Two of the 16 high-quality studies examining the DCS model provided support for the DC model (Barnett & Brennan, 1997; Bromet et al., 1988), 1 study provided support for the DCS model (Parkes et al., 1994); and 5 studies (Bourbonnais et al., 1999; Dollard, 1997; Parkes, 1982; Steptoe et al., 1998; Vahtera et al., 2000) provided support for the strain hypothesis of both the DC and DCS model. Surprisingly, the study of Parkes et al. (1994) found only support for the strain hypothesis of the DCS model and not for the DC model. This result could be due to the fact that the authors did not control for the DC effects separately in their stepwise regression analyses (in the first steps the influence of social support was also included).

More evidence in studies employing heterogeneous populations? With the information presented in Table 2.4 we can also test the aforementioned assumption that heterogeneous populations are more useful for testing the effects of (combinations of) job characteristics. Of the high-quality studies, 11 studies (58%) are based on heterogeneous populations and 8 studies (42%) on homogeneous populations. Table 2.4 shows that of 4 of the 11 heterogeneous studies (36%) provided evidence for the strain hypothesis (Barnett & Brennan, 1997; Bromet et al., 1988; Steptoe et al., 1998; Vahtera et al., 2000), whereas 4 of the 8 homogeneous studies also (50%) provided evidence for the strain hypothesis (Bourbonnais et al., 1999; Dollard, 1997; Parkes, 1982; Parkes et al., 1994). A Pearson chi-square test revealed that the number of studies supporting the strain hypothesis did not differ for homogeneous vs. heterogeneous samples, chi-square (df = 1, N = 19) = .35, p >

.50. Thus, studies employing heterogeneous populations do not provide more evidence for the strain hypothesis than homogeneous populations.

Summarizing, only 8 of the 19 high-quality studies (42%) provided support for the strain hypothesis of the DC/S model; that is, they revealed joint effects of demands, control and/or social support in predicting health outcomes over time (Barnett & Brennan, 1997; Bourbonnais, et al., 1999; Bromet et al., 1988; Dollard, 1997; Parkes, 1982; Parkes et al., 1994; Steptoe et al., 1998; Vahtera et al., 2000). Consequently, the high-quality studies provide only modest support for the strain hypothesis of the DC/S model.

2.4.4 Causation

In spite of the modest support for the strain hypothesis, the studies do present clear evidence for causal relationships between work characteristics and health across time. Virtually all high-quality studies (with the exceptions of Chapman et al., 1990; Hjollund et al., 1998; Landsbergis & Hatch, 1996) provide evidence for a normal causal relationship between one or more of the dimensions of the DC/S model and the outcome variables. The studies of Carayon (1992, 1993) were the only high-quality studies that explicitly examined reversed or reciprocal causal relationships. These studies revealed only evidence for normal causal relationships.

When examining the DCS dimensions separately, the following findings emerge. Twelve high-quality studies (63%) reported significant main effects of *job demands* in predicting physical and psychological indicators of strain (mostly psychological well-being and sickness absence). The majority of these main effects occurred in conjunction with a main effect of control and/or social support. In addition, nine high-quality studies (47%) reported main effects of *job control* on the outcome variables (i.e., psychological distress, cardiovascular measures and life style factors). These main effects occurred usually in conjunction with a main effect of demands and/or social support. Furthermore, nine high-quality studies (47%) reported main effects for *social support* in predicting psychological well-being and alcohol consumption. Again, the majority of these main effects occurred in conjunction with main effects of demands and/or control.

Consequently, 16 studies (84%) provided evidence for normal causal effects of job demands, job control or social support on various types of outcomes.

2.5 Discussion

The present chapter reviewed the methodological quality of 45 longitudinal studies examining the DC/S model using five evaluation criteria (study design, argument for the time lags used, quality of measures, method of analysis and nonresponse analysis). Nineteen *high-quality* studies (42%) were identified, obtaining at least *sufficient* ratings on all criteria. Perhaps somewhat surprisingly, these studies provided only modest support for the strain hypothesis of the DC/S model. Only 8 studies (42% of the high-quality studies; Barnett & Brennan, 1997; Bourbonnais et al., 1999; Bromet et al., 1988; Dollard, 1997; Parkes, 1982; Parkes et al., 1994; Steptoe et al., 1998; Vahtera et al., 2000) demonstrated the expected *combination* of additive and/or multiplicative interaction effects of the DC/S dimensions, usually in the form of additive effects. Furthermore, our results indicate that studies based on heterogeneous populations (with more exposure contrast) do not provide more support for the strain hypothesis than studies based on homogeneous populations. This suggests that homogeneous populations provide enough true individual and within-occupation variation in job characteristics (i.e., provide enough exposure contrast) to be as useful as heterogeneous samples in testing the DC/S model.

Further, the fact that the included studies reported few interaction effects is consistent with previous (mainly cross-sectional) findings that multiplicative interaction effects are rare (Kasl, 1996; Kristensen, 1995; Theorell & Karasek, 1996). Most effects were found for the self-reported measures of health and/or well-being. Thus, the results of high-quality studies do *not* provide stronger support for the DC/S model than the mixture of excellent and not-so-excellent studies included in previous reviews. This implies that the results strongly resemble those obtained in reviews of cross-sectional studies, suggesting that the hints forwarded in previous research that the dimensions of the DC/S model affect worker health *causally* are not entirely based on wishful thinking combined with too-simple research designs. Moreover, 16 of the 19 high-quality studies (84%) included in this review provided clear support for normal causal relationships between work and health across time. Note, however, that the majority of these studies solely explored *normal* causal relationships; reversed or reciprocal causal relationships were only explored by Carayon (1992, 1993).

Study limitations. Four limitations of this review are worth mentioning. First, the evaluation criteria that were applied in this review are not always applicable for every

outcome variable. For example, this review evaluated a complete panel design as either *good* or *very good*, because this type of design provides the opportunity to examine all three types of causation. However, such a design is not always necessary, e.g., when examining an outcome such as mortality. In this case exploring reversed or reciprocal causal relationships becomes superfluous, as the score on the outcome variable is irreversible once a particular end state has been reached. This problem follows directly from formulating general evaluation criteria for different kinds of outcomes. Moreover, the provided information on whether the selected studies tested different types of causation was not used for evaluating the studies.

A related limitation concerns the choice of evaluation criteria. Whereas the five criteria employed in this study reflect common insights obtained from general and longitudinal research methodology, it is always possible to think of other criteria that might have been applied. One such criterion concerns the validity of the measures used, especially the measures for job demands and job control. It has been argued that global measures of job demands (e.g., the measures in Karasek et al.'s (1998) JCQ) may be ill-suited to measure the demands that are relevant in a particular occupation, meaning that employing global measures will lead to underestimation of the effects of job demands on the outcome variables (de Jonge, Dollard, Dormann, Le Blanc & Houtman, 2000). A similar case could be made for inclusion of job-specific control instead of using global control measures (cf. McLaney & Hurrell, 1988; Sargent & Terry, 1998). It would be interesting to see if studies using job-specific demands provide more support for the strain hypothesis compared with the results of studies employing more global measures (e.g., the JCQ or similar instruments). Unfortunately, we were unable to examine this issue as only five of the 45 included studies (11%; Daniels & Guppy, 1994; Dollard, 1997; Johnson et al., 1995; Landsbergis & Hatch, 1996; Pollard et al., 1996) used measures that might be construed as measures that were tailored towards the job or population under study.

Third, this review mainly paid attention to the results of the 19 high-quality studies; the other 26 studies were not examined in great detail. Our assumption was that evidence from methodologically impeccable longitudinal research on the DC/S model would be especially valuable in judging the evidence for the DC/S model. The results of the 26 other studies might present an under- or overestimation of the effects of work on health, as a result of different forms of bias. In other words, we can put less confidence in such results as we do

not know how such low quality research designs may have influenced the results reported in these studies. From this vantage point, inclusion of other, less well-designed studies is considered irrelevant. However, to examine whether the results of the high-quality studies differed from those obtained in the other studies, a limited comparison between the results of both types of studies was conducted. This analysis revealed that 11 of the 26 low quality studies provided support for the strain hypothesis of the DC/S model (as defined in our introduction) compared to eight of the 19 high-quality studies. A Pearson chi-square test revealed that the number of studies supporting the strain hypothesis did not differ as a function of study quality, chi-square ($df = 1$, $N = 45$) = .60, $p > .50$). Thus, the results from the 19 high-quality studies confirm the modest support found in earlier reviews (e.g., van der Doef & Maes, 1999).

A final limitation of this study is that some of the studies included in the present review were based on partly the same data set (Bosma et al., 1997; 1998; Carayon, 1992; 1993; Stansfeld et al., 1997-1999; the first four studies were denoted as high-quality studies). This implies that the results of these studies are not statistically independent, meaning that they provide no statistically independent evidence regarding the effects of demands, control and support. In both studies by Bosma et al. (1997, 1998) main effects of control were found, while the main effects of demands and support were not significant. In the Carayon (1992, 1993) studies no main effects of control were found, but job demands affected the outcome variables in both studies. As the results of these studies more or less counterbalance each other (control significant in one study, but insignificant in another) our conclusions concerning the impact of demands, control and support on the outcome variables do not change if these studies would not be taken into account.

Recommendations for future research. On the basis of this review, we highlight seven issues that would seem to deserve more attention in future research on the DC/S model.

More research on specific (and "objective") outcomes. The majority of the studies included in this review have examined self-report measures representing health or well-being, and cardiovascular measures (see Schnall et al., 1994, and Schnall et al., 2000, for more comprehensive reviews on cardiovascular disease). High-quality longitudinal research examining other types of outcomes as sickness absence, and physiological measures is clearly needed to provide a more complete picture of the effects of work characteristics on health and the mechanisms underlying these effects. In addition, the relative paucity of

research using objective measures (such as registered sickness absence and mortality) makes it difficult to evaluate the value of the DC/S model in predicting these types of outcomes.

More research on the effects of stable and changing DC/S dimensions over time. Karasek and Theorell (1990) argued that the relation between duration of exposure to an unfavorable work situation and health may be non-linear, such that long-term exposure has stronger detrimental effects than short-term exposure. Unfortunately, the majority of the high-quality longitudinal studies examined here have ignored the issue of *cumulative* exposure to high demands and low control (and low social support; "DC/S histories"). These studies mostly investigated the effects of Time 1 DC/S dimensions on Time 2 outcome(s). Consequently, the DC/S effects are based on a "one or two snap assessment" and not on longer DC/S histories. Similarly, only few longitudinal studies have addressed the health effects of *across-time change* in job demands and control. It would be particularly interesting to examine the effects of *change* in work characteristics on worker health: e.g., does a change from a high strain job to a low strain job coincide with an improvement in worker health? Such research is scarce (for exceptions see de Lange et al., 2002; Schnall et al., 1998; Swaen et al., 2002), yet this type of analysis would further validation of the DCS model.

More research on the impact of different time lags. Table 2.4 shows some consistent effects for, for example, the relationship between social support and job satisfaction (demonstrated with a time lag between 1 month or 1 year), and for additive effects of the DC/S dimensions on psychological well-being, burnout and anxiety (demonstrated with a time lag of 1 year) over time. The results were less consistent for the other end points.

It is too early to draw strong conclusions from these results with respect to the "right" time lag for examining the effects of work characteristics on health, because the issue of which time lag is "right" depends on various factors, such as the type of outcome being measured, the amount of exposure to the stressors of interest, and whether or not changes in work characteristics or job changes have taken place. It is important that the time lag suits the process and etiology of the relationships between the research variables over time.

One recommendation that could be based on our findings is that researchers should design studies with many follow-up measures that are both evenly and unevenly spaced. By using unevenly spaced time lags researchers can explore different effects of stressors over

time; by using evenly spaced time lags time-variant effects such as seasonal effects can be controlled for. On the other hand, researchers should realize that a design with many follow-up measurements might seriously reduce response among employees. Of course, in examining the impact of work characteristics on health the effects of across-time change in job conditions must be considered (Landsbergis & Theorell, 2000; see recommendation 2).

More research using different cutoff points. One standard approach to examining worker health in relation to the Karasek model is to examine worker health as a function of the type of job one holds: a high strain job, a low strain job, an active job, or a passive job. To obtain four job quadrants, demands and control are often dichotomized using the median split. Sixteen of the 45 longitudinal studies used this "relative" approach. As yet it is unclear whether the choice of the cutoff point influences results (Hammar et al., 1998): Would results have been the same if a different cut-off point had been chosen? It is possible that in various studies the four Karasek job types are not that different at all. Given a particular amount of variation in job demands and job control, it is *always* possible to create the four Karasek job types: yet, due to restriction of range in some studies this variation might largely consist of error variance, meaning that no substantive health differences among the groups will be expected (no "objective" exposure contrast). In such cases comparison of more extreme sub groups (i.e., groups that differ substantially as regards their amount of job demands and job control; e.g., based on 25^{th} percentiles) may be a more fruitful approach. It is therefore important to explore in more detail effects of using various cut-off points.

Furthermore, any dichotomous method loses information when compared to using a continuous scale. Therefore besides using information based on cutoff points, we advise to use regression methods (retaining continuous scores) and to evaluate the regression lines at fixed points above and below the mean from the regression equation (cf. Landsbergis & Theorell, 2000).

More research on reversed and reciprocal causation. Whereas it is widely acknowledged that work characteristics influence worker health, earlier research suggests that health may influence (the evaluation of) work as well (e.g., de Jonge et al., 2001; Taris, 1999). However, virtually none of the studies selected for this review examined the effects of health on work outcomes (with the notable exception of Carayon, 1992, 1993). Future longitudinal research on the DC/S model should address such questions to obtain a fuller

understanding of the dynamic interplay between work and worker health, and to find out which path is dominant.

More discussion concerning the impact of various confounders. In Table 2.2 we described the different types of confounders which were controlled for in the 45 selected studies. Most of these (N = 41) controlled for demographic variables. Nevertheless, Table 2.2 also showed some inconsistency in the types of confounders controlled for in relation to the type of outcome. Some studies examining similar outcomes controlled for more confounders compared to others. We cannot draw any conclusions from our data as regards which (amount of) confounders should be controlled for when examining particular outcomes. Whether a researcher should control for a particular variable depends strongly of the process under study -- but as the precise nature of this process is often largely unknown, it is also unknown to decide *which* variables should be controlled for. However, future research should discuss in more detail why one should control for a particular confounder in relation to the nature of the process under study.

More research examining the activation hypothesis. The present review focused on the strain hypothesis of the DC/S model. However, Karasek and Theorell (1990) not only assume that particular combinations of job characteristics lead to strain; they also argue that some job types (i.e., active jobs) are conducive to learning, whereas other (passive) jobs inhibit learning (the *activation*, *motivation* or *learning hypothesis*). As were earlier reviews (van der Doef & Maes, 1999; Kasl, 1996; Kristensen, 1995), the results of the current review are limited to the high strain hypothesis of the DC/S model: Hardly any research explicitly addresses the activation (or motivation) hypothesis of the DC/S model (but see Holman & Wall, 2002; Taris, Kompier, de Lange, Schaufeli, & Schreurs, 2003 for a review). This would not be so important, were it not that Karasek and Theorell (1990) assume that strain and learning mutually influence each other. For example, employees in active jobs will develop new skills that allow them to deal more effectively with the inevitably strain-inducing situations in their jobs. Thus, in order to obtain a fuller understanding of the relationship between work characteristics and health, more research on the activation hypothesis would seem desirable.

References

(1) Barnett, R.C., & Brennan, R.T. (1997). Change in job conditions, change in psychological distress, and gender: A longitudinal study of dual-earner couples. *Journal of Organizational Behaviour, 18,* 253-274.

(2) Bosma, H., Marmot, M.G., Hemingway, H., Nicholson, A.C., Brunner, E., & Stansfeld, S.A. (1997). Low job control and risk of coronary heart disease in Whitehall II (prospective cohort) study. *British Medical Journal, 314,* 558-564.

(3) Bosma, H., Peter, R., Siegrist, J., & Marmot, M. (1998). Alternative job stress models and the risk of coronary heart disease: the effort-reward imbalance and the job strain model. *American Journal of Public Health, 88,*68-74.

(4) Bourbonnais, R., Comeau, M., & Vezina, M. (1999). Job strain and evolution of mental health among nurses. *Journal of Occupational Health Psychology, 4,* 95-107.

(5) Bromet, E.J., Dew, M.A., Parkinson, M.S., & Schulberg, H.C. (1988). Predictive effects of occupational and marital stress on the mental health of a male work force. *Journal of Organizational Behavior, 9,* 1-13.

(6) Carayon, P. (1992). Longitudinal study of job design and worker strain: preliminary results. In J. Campbell Quick, L.R. Murphy and J.J. Hurrell (Eds), *Stress & well-being at work* (pp. 19-32). Washington: APA.

(7) Carayon, P. (1993). A longitudinal test of Karasek's job strain model among office workers. *Work & Stress, 7,* 299-314.

(8) Chapman, A., Mandryk, J.A., Frommer, M.S., Edye, B.V., et al. (1990). Chronic perceived work stress and blood pressure among Australian government employees. *Scandinavian Journal of Work, Environment and Health, 16,* 258-269.

(9) Cheng, Y., Kawachi, I., Coakley, E.H., Schwartz, J., & Colditz, G. (2000). Association between psychosocial work characteristics and health functioning in American women: prospective study. *British Medical Journal, 320,* 1432-1436.

Cook, T.D., & Campbell, D.T. (1979). *Quasi-experimentation: Design and analysis for field settings.* Boston: Houghton Mifflin.

(10) Crum, R. M., Muntaner, C., Eaton, W.W., & Anthony, J.C. (1995). Occupational stress and the risk of alcohol-abuse and dependence. *Alcoholism: Clinical and Experimental Research, 19,* 647-655.

(11) Daniels, K., & Guppy, A. (1994). Occupational stress, social support, job control, and psychological well-being. *Human Relations, 12,* 1523-1544.

Doef, M.P. van der, & Maes, S. (1999). The Job Demand-Control(-Support) Model and psychological well-being: A review of 20 years of empirical research. *Work & Stress, 13,* 87-114.

(12) Doef, M.P. van der, & Maes, S. (2000). Do (changes in) job conditions affect health and well-being among nursing home employees? In: *The Job Demand-Control-*

Support model: from the past to the future (PhD Thesis). Enschede: Printpartners Ipskamp.

(13) Dollard, M.F. (1997). *Work stress: Conceptualisations and implications for research methodology and workplace intervention.* (PhD Thesis). Whyalla: Work & Stress Research Group, University of South Australia.

(14) Egeren, L.F., van (1992). The relationship between job strain and blood pressure at work, at home, and during sleep. *Psychosomatic Medicine, 54,* 337-343.

(15) Fenwick, R., & Tausig, M. (1994). The macroeconomic context of job stress. *Journal of Health and Social Behaviour, 35,* 266-282.

Frese, M. (1984). Job transitions, occupational socialisation and strain. In V. Allen & E. van de Vliert (Eds), *Role transitions.* New York: Plenum Press.

Frese, M., & Zapf, D (1988). Methodological issues in the study of work stress: Objective vs subjective measurement of work stress and the question of longitudinal studies. In C.L. Cooper & R. Payne (red.), *Causes, coping and consequences of stress at work* (pp. 375-411). Chichester: John Wiley & Sons Ltd.

(16) Furda, J., de Jonge, J., le Blanc, P., Meijman, T., Schreurs, P., & Scheenen, J. (1994). Het Demand-control-support model in relatie tot gezondheidsklachten en herstelklachten: Een longitudinale studie. <The Demand-Control-Support model in relation to health complaints and recovery complaints: a longitudinal study>. *Gedrag en Organisatie, 7,* 225-238.

Greenland, S. (1998). Introduction to Regression Modeling. In K. J. Rothman & S. Greenland (Eds.), *Modern epidemiology* (p. 385). Philadelphia: Lippincott-Raven Publishers.

(17) Hammar, N., Alfredsson, L., Johnson, J.V. (1998). Job strain, social support at work, and incidence of myocardial infarction. *Occupational and Environmental Medicine, 55,* 548-553.

(18) Hjollund, N.H.I., Jensen, T.K., Bonde, J.P.E., Henriksen, T.B., Kolstad, H.A., Andersson, A., Ernst, E., Giwercman, A., Skakkebaek, N.E., & Olsen, J. (1998). Job strain and time to pregnancy. *Scandinavian Journal of Work, Environment and Health, 24,* 344-350.

Holman, D.J., & Wall, T.D. (2002). Work characteristics, learning-related outcomes, and strain: a test of competing direct effects, mediated, and moderated models. *Journal of Occupational Health Psychology, 7*, 283-301.

Houtman, I., Kornitzer, M., De Smet, P., et al. (1999). Job stress, absenteeism and coronary heart disease European cooperative study (the JACE study): Design of a multicentre prospective study. *European Journal of Public Health, 9,* 1, 52-57.

Johnson, J.V., & Hall, E.M. (1988). Job strain, work place social support, and cardiovascular disease: A cross-sectional study of a random sample of the Swedish working population. *American Journal of Public Health, 78,* 1336-1342.

(19) Johnson, J.V., Hall, E.M., Ford, D.E., Mead, L.A., Levine, D.M., Wang, N.Y., & Klag, M.J. (1995). The psychosocial work environment of physicians: The impact of demands and resources on job dissatisfaction and psychiatric distress in a longitudinal study of Johns Hopkins Medical School graduates. *Journal of Occupational and Environmental Medicine, 37,* 1151-1159.

(20) Johnson, J.V., Hall, E.M., & Theorell, T. (1989). Combined effects of job strain and social isolation on cardiovascular disease morbidity and mortality in a random sample of the Swedish male working population. *Scandinavian Journal of Work, Environment and Health, 15*, 271-279.

(21) Johnson, J.V., & Stewart, W.F. (1993). Measuring work organization exposure over the life course with a job-exposure matrix. *Scandinavian Journal of Work, Environment and Health, 19,* 21-28.

Jonge, de, J., Dollard, M.F., Dormann, C., Le Blanc, P.M., & Houtman, I.L.D. (2000). The Demand-Control model: Specific demands, specific control, and well-defined groups. *International Journal of Stress Management, 7*, 269-187.

Jonge, de, J., Dormann, C., Janssen, P.P.M., Dollard, M.F., Landeweerd, J.A., & Nijhuis, F.J.N. (2001). Testing reciprocal relationships between job characteristics and psychological well-being: A cross-lagged structural equation model. *Journal of Occupational and Organizational Psychology, 74,* 29-46.

Jonge, J. de, & Kompier, M.A.J. (1997). A critical examination of the Demand-Control-Support Model from a work psychological perspective. *International Journal of Stress Management, 4*, 235-258.

(22) Jonge, J. de, Le Blanc, P. M., Schaufeli, W. B., & van der Linden, S. (1998). Verandering in werkkenmerken in relatie tot verandering in burnout en arbeidstevredenheid <Changes in job characteristics as related to changes in burnout and job satisfaction>. *Gedrag en Organisatie, 11*, 121-134.

(23) Karasek, R. A. (1979). Job demands, job control, and mental strain: Implications for job redesign. *Administrative Science Quarterly, 24,* 285-308.

Karasek, R. A. (1989). Control in the workplace and its health-related aspects. In S.L. Sauter, J.J. Hurrell and C.L. Cooper (Eds), *Job control and work health* (pp. 129-159). New York: Wiley.

(24) Karasek, R., Baker, D., Marxer, F., Ahlbom, A., & Theorell, T. (1981). Job control, job demands and cardiovascular disease: A prospective study of Swedish men. *American Journal of Public Health, 71,* 694-705.

Karasek, R., et al. (1998). The Job Content Questionnaire: An instrument for internationally comparative assessments of psychosocial job characteristics. *Journal of Occupational Health Psychology, 3*, 322-355.

Karasek, R., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life.* New York: Basic Books.

Kasl, S. V. (1996). The influence of the work environment on cardiovascular health: A historical, conceptual, and methodological perspective. *Journal of Occupational Health Psychology, 1,* 42-56.

(25) Kivimäki, M., Vahtera, J., Pentti, J., & Ferrie, J. E. (2000). Factors underlying the effect of organisational downsizing on health of employees: A longitudinal cohort study. *British Medical Journal, 320,* 971-975.

Kessler, R.C., & Greenberg, D.F. (1981). *Linear panel analysis: Models of quantitative change*. New York: Academic Press.

Kristensen, T.S. (1995) The Demand-Control-Support model: Methodological challenges for future research. *Stress Medicine, 11,* 17-26.

Kristensen, T.S. (1996). Job stress and cardiovascular disease: A theoretical critical review. *Journal of Occupational Health Psychology, 3,* 246-260.

(26) Landsbergis, P.A., & Hatch, M.C. (1996). Psychosocial work stress and pregnancy induced hypertension. *Epidemiology, 7,* 346-351.

(27) Landsbergis, P.A., Schnall, P.L., Deitz, D.K., Warren, K., Pickering, T.G., & Schwartz, J.E. (1998). Job strain and health behaviors: Results of a prospective study. *American Journal of Health Promotion, 12,* 237-245.

Landsbergis, P., & Theorell, T. (2000). Measurement of psychosocial workplace exposure variables. In P. L. Schnall, K. Belkić, P. Landsbergis, & D. Baker (Eds.), The workplace and cardiovascular disease (pp 163-189). *Occupational Medicine: State of the Art Reviews,* 15, 1.

Landsbergis, P.A., Schnall, P.L., Warren, K., Pickering, T.G., & Schwartz, J.E. (1994). Association between ambulatory blood pressure and alternative formulations of job strain. *Scandinavian Journal of Work, Environment and Health, 20,* 349-363.

Lange, A.H. de, Taris, T.W., Kompier, M.A.J., Houtman, I.L.D., & Bongers, P.M. (2002). The effects of stable and changing demand-control histories on worker health: Results of the longitudinal SMASH study. *Scandinavian Journal of Work, Environment and Health, 28*, 94-108.

McLaney, M. A., Hurrell, J. J. (1988). Control, stress and job satisfaction in Canadian nurses. *Work & Stress, 2,* 217-224.

(28) Muntaner, C., Tien, A.Y., Eaton, W.W., & Garrison, R. (1991). Occupational characteristics and the occurence of psychotic disorders. *Social Psychiatry and Psychiatry Epidemiology, 26,* 273-280.

Nesselroade, J.R., et al. (1979). *Longitudinal research in the study of behavior and development*. New York: Academic Press.

(29) Noor, N.M. (1995). Work and family roles in relation to women's well-being: A longitudinal study. *British Journal of Social Psychology, 34,* 87-106.

(30) Parkes, K.R. (1982). Occupational stress among student nurses: A natural experiment. *Journal of Applied Psychology, 6,* 784-796.

(31) Parkes, K.R. (1991). Locus of control as moderator: An explanation for additive versus interactive findings in the demand-discretion model of work stress? *British Journal of Psychology, 82,* 291-312.

(32) Parkes, K.R., Mendham, C.A., & Rabenau, C. von (1994). Social support and the demand-discretion model of job stress: tests of additive and interactive effects in two samples. *Journal of Vocational Behavior, 44,* 91-113.

(33) Pollard, T.M., Ungpakorn, G., Harrison, G.A., & Parkes, K.R. (1996). Epinephrine and cortisol responses to work: A test of the models of Frankenhaeuser and Karasek. *Annals of Behavioral Medicine, 18,* 229-237.

(34) Reed, D.M., LaCroix, A.Z., Karasek, R.A., DeWolfe Miller, & Maclean, C.A. (1989). Occupational strain and the incidence of coronary heart disease. *American Journal of Epidemiology, 129,* 495-502.

(35) Riese, H., van Doornen, L.J.P., Houtman, I.L.D., & De Geus, E.J.C. (2000). Job strain and risk indicators for cardiovascular disease in young female nurses. *Health Psychology, 19,* 429-440.

Sargent, L. D., & Terry, D. J. (1998). The effects of work control and job demands on employee adjustment and work performance. *Journal of Occupational and Organizational Psychology, 71*, 219-236.

Schnall, P.L., Landsbergis, P.A., & Baker, D. (1994). Job strain and cardiovascular disease. *Annual Review of Public Health, 15,* 381-411.

Schnall, P. L., Belkić, K., Landsbergis, P. & Baker, D. (2000). The workplace and cardiovascular disease. *Occupational Medicine: State of the Art Reviews, 15*, 1-319.

(36) Schnall, P. L., Schwartz, J. E., Landsbergis, P.A., Warren, K., & Pickering, T. G. (1998). A longitudinal study of job strain and ambulatory blood pressure: Results from a three year follow-up. *Psychosomatic Medicine, 60,* 697-706.

Schreurs, P. J. G., Taris T. W., Schaufeli W. B. (1999). Arbeidsbelasting, stress en burnout in de zorg (Work load, stress, and burnout in health organizations). In J. Pool & H. van Dijk H (Eds.). Bouwstenen voor personeelsmanagement in de zorg. Deel 2: Ontwikkeling en duurzame interne inzetbaarheid van personeel (pp. 113-127). Houten: Bohn, Stafleu en Van Loghum.

(37) Smulders, P.G.W., & Nijhuis, F.J.N. (1999). The Job demands-Job Control model and absence behaviour: Results of a 3-year longitudinal study. *Work & Stress, 13,* 115-131.

Spector, P. E., Zapf, D., Chen, P. Y., Frese, M. (2000). Why negative affectivity should not be controlled in job stress research: Don't throw out the baby with the bath water. *Journal of Organizational Behavior, 21*, 79-95.

Stangor, C. (1998). *Research methods for the behavioral sciences*. New York: Houghton Mifflin.

(38) Stansfeld, S.A., Bosma, H., Hemingway, H., & Marmot, M.G. (1998). Psychosocial work characteristics and social support as predictors of SF-36 health functioning: The Whitehall II study. *Psychosomatic Medicine, 60,* 3, 247-255.

(39) Stansfeld, S.A., Fuhrer, R., Head, J., Ferrie, J., & Shipley, M. (1997). Work and psychiatric disorder in the Whitehall II study. *Journal of Psychosomatic Research, 43,* 73-81.

(40) Stansfeld, S.A., Fuhrer, R., Shipley, M.J., & Marmot, M.G.(1999). Work characteristics predict psychiatric disorder: prospective results from the Whitehall II study. *Occupational Environmental Medicine, 56,* 302-307.

(41) Steenland, K., Johnson, J., & Nowlin, S. (1997). A follow-up study of job strain and heart disease among males in the NHANES1 population. *American Journal of Industrial Medicine, 31,* 256-260.

(42) Steptoe, A., Wardle, J., Lipsey, Z., Mills, R., Oliver, G., Jarvis, M., & Kirschbaum, C. (1998). A longitudinal study of work load and variations in psychological well-being, cortisol, smoking and alcohol consumption. *Annals of Behavioral Medicine, 20,* 84-91.

Swaen, M.H., Kant, Y., Amelsvoort, L.G.P.M. van, Beurskens, A.J.H.M. (2002). Job mobility, its determinants, and its effects: Longitudinal data from the Maastricht cohort study. *Journal of Occupational Health Psychology, 7*, 121-129.

Taris, T.W. (1999). The mutual effects between job resources and mental health: A prospective study among Dutch youth. *Genetic, Social, and General Psychology Monographs, 125*, 433-450.

Taris, T. W. (2000). *A primer in longitudinal data analysis.* Londen: Sage.

Taris, T., & Kompier, M. (2003). Challenges of longitudinal designs in occupational health psychology. *Scandinavian Journal of Work, Environment and Health, 29,* 1-4.

Taris, T. W., Kompier, M. A. J., Lange, A. H., de, Schaufeli, W. B., & Schreurs, P. J. G. (2003). Learning new behaviour patterns: a longitudinal test of Karasek's active learning hypothesis among Dutch teachers. *Work & Stress*, *1*7, 1-20.

Theorell, T. (2000). Job characteristics in a theoretical and practical health context. In C.L. Cooper (Ed.) Theories of organizational stress (pp. 205-245). Oxford: Oxford University Press.

Theorell, T., & Karasek, R. A. (1996). Current issues relating to psychosocial job strain and cardiovascular disease research. *Journal of Occupational Health Psychology, 1,* 9-26.

(43) Theorell, T., Karasek, R.A., & Eneroth, P. (1990). Job strain variations in relation to plasma testosterone fluctuations in working men-a longitudinal study. *Journal of Internal Medicine, 227,* 31-6.

(44) Vahtera, J., Kivimäki, M., Pentti, J., & Theorell, T. (2000). Effect of change in the psychosocial work environment on sickness absence: A seven year follow up of

initially healthy employees. *Journal of Epidemiology and Community and Health, 54,* 484-493.

(45) Vahtera, J., Pentti, J., & Uutela, A. (1996). The effect of objective job demands on registered absence spells: Do personal, social and job-related resources act as moderators? *Work & Stress, 10,* 286-308.

Zapf, D., Dormann, C., & Frese, M. (1996). Longitudinal studies in organizational stress research: A review of the literature with reference to methodological issues. *Journal of Occupational Health Psychology, 1,* 145-169.

3

Examining normal, reversed and reciprocal relationships in a 4-wave study

Appeared as:

De Lange, A. H., Taris, T. W., Kompier, M. A. J., Houtman, I. L. D., Bongers, P. M. (2004). The relationships between work characteristics and mental health: Examining normal, reversed and reciprocal relationships in a 4-wave study. *Work & Stress, 18,* 149-166

3.1 Abstract

This longitudinal study examined the causal relationships between job demands, job control and supervisor support on the one hand and mental health on the other. Whereas we assumed that work characteristics affect mental health, we also examined reversed causal relationships (mental health influences work characteristics). Further, the topic of the appropriate time lag for testing causal relationships was addressed. Our hypotheses were tested in a 4-wave study among a heterogeneous sample of 668 Dutch employees using structural equation modeling. The results provide evidence for reciprocal causal relationships between the work characteristics and mental health, although the effects of work characteristics on well-being were causally predominant. The best model fit was found for a 1-year time lag. Compared to earlier -- predominantly cross-sectional -- results, the present study presents a stronger case for the effects of work characteristics on the development of strain. The results also emphasize the need for a dynamic view of the relationship between work and health; the one-directional viewpoint in many work stress models does not seem to fully capture the relations between work characteristics and well-being.

3.2 Introduction

For several decades the Demand-Control-Support model (DCS model; Johnson & Hall, 1988; Karasek & Theorell, 1990) has been one of the dominant work stress models in the field of occupational health psychology. According to the model, employees working in high strain jobs (i.e. jobs characterized by high job demands, low job control and low social support) will experience a higher than average number of health problems over time (e.g. high blood pressure, low mental health) than workers in other jobs. This strain or "iso-strain" hypothesis has been tested extensively, revealing mixed support for this hypothesis (Belkić, Schnall, Landsbergis & Baker, 2004; de Lange et al., 2003; van der Doef & Maes, 1999 for reviews).

Structural models such as the DCS model focus on specific aspects in the complex psychosocial work environment to explain how individuals perceive and react to their job. One basic assumption of the DCS model (and most other work stress models) is that the relationship between work and health is *one-directional*, such that work characteristics as measured at one point in time influence health at a later point in time. Such effects of work characteristics on health will be denoted as *normal* causal relationships in the remainder of this study. The DCS model does not take into account that the associations between work characteristics and health may also be explained by *reversed* causal relationships (in which Time 1 health influences Time 2 job demands) or *reciprocal* (bi-directional) relationships in which the DCS dimensions and health mutually influence each other (Williams & Podsakoff, 1989; Zapf et al., 1996). We believe that in order to obtain a better understanding of the relationship between work characteristics and health, one should also investigate these other possible relationships between work and health (Bollen, 1989; Hurrell et al., 1998).

The present paper focuses on the question of whether the associations between work characteristics and health are due to normal causal relationships (i.e., work characteristics influence health) or reversed/reciprocal relationships. The answer to this question has practical as well as theoretical implications, as evidence for reversed or reciprocal causal relationships implies that adjustments to the interpretation and presentation of the Demand-Control-Support model are needed. Evidence for reversed causal effects would necessitate further theorizing as to the specific underlying mechanisms that might explain such reversed effects, as currently little theorizing is available (cf. Spector et al., 2000; Zapf et

al., 1996). Following these researchers, our point of departure is that reversed effects of mental health status may be due to either *real* positive or negative changes of the work environment (environmental changes) or to changes in the *evaluation* of the *same* work environment (perceptual changes). For example, a negative reversed lagged effect of depression on the DCS dimensions might be explained by two different processes, namely the depressed worker (a) perceives his or her work environment more negatively (perceptual change), or the depressed worker 'drifts off' to a more negative work environment as a result of (b) a job transfer or (c) changes within the same job (environmental change; Zapf et al., 1996). Before trying to disentangle such reverse causation mechanisms, the primary question is whether we can indeed find evidence for reversed effects of mental health on work across time.

We first present a brief review of the evidence for reversed and reciprocal causal relationships between work characteristics and health. Then we examine the (normal and reversed) relationships between work characteristics and health in a 4-wave study using data from a heterogeneous sample of 688 Dutch employees.

Evidence for reversed and reciprocal causal relationships? Few longitudinal studies in occupational health psychology have explored reversed and reciprocal causal relationships. In a recent review, de Lange et al. (2003) found that only 2 of 19 (11%) high-quality longitudinal studies examining the effects of demands, control and support on worker health explicitly tested reversed or reciprocal causal relationships. These two studies provided no support for reversed or reciprocal causal relationships. Zapf et al. (1996) found that only 15 of the 39 longitudinal organisational stress studies in their review explored reversed causal relationships. Seven of these 15 studies (47%) supported these relationships. For example, Kohn and Schooler (1982) found evidence for an effect of anxiety on time pressure, whereas Marcelissen et al. (1988) found an effect of health complaints (e.g. strain, worry, and diastolic blood pressure) on coworker support.

Recent longitudinal studies on work stress have also presented evidence for reversed or reciprocal causal relationships. For example, Bakker et al. (2000) found that high levels of Time 1 depersonalisation were associated with higher Time 2 frequency and intensity of patient demands, whereas de Jonge et al. (2001) reported a positive longitudinal effect of emotional exhaustion on job demands. Similarly, Leiter and Durup (1996) found a reversed relationship between emotional exhaustion on the one hand and work overload and

supervisor support on the other. Taris et al. (1998) found evidence for reciprocal effects between job characteristics and depression. Depressive workers who experienced a job change reported less positive outcomes compared to non-depressive workers who changed jobs. Finally, Taris (1999) reported that job characteristics (e.g. variety, autonomy and job security) and mental health (depression, self-esteem and general health) mutually influenced each other.

Thus, it seems that there is some reason to assume that work characteristics and mental health mutually influence each other. However, many of the studies discussed above suffer from methodological shortcomings. First, not all studies employed a design in which the same variables were measured at all occasions for the same panel of respondents. Such a design is needed to adequately test reversed or reciprocal causal relationships, as it allows for examining changes in variables and in associations between variables over time (Kessler & Greenberg, 1981).

Second, not all studies used structural equation modeling (SEM) for testing these effects. Several researchers (e.g., Williams & Podsakoff, 1989) advise to use SEM instead of simpler techniques as SEM can: i) account for correlated measurement errors over time; ii) estimate different types of causation simultaneously in a multi-variable/multi-wave model; and iii) control for various method and third variable problems (Zapf et al., 1996). Further, SEM can be used for determining causal priority or causal predominance when finding reciprocal relationships. That is, if lagged effects of both work characteristics on health and health on work are found, SEM can be used to test whether the normal or the reversed causal relationship is causally predominant (Byrne, 2002; Rogosa, 1980).

Third, the majority of these longitudinal studies neglected the issue of the appropriateness of the time lag used in these studies for examining the relationship between work and health. One basic assumption in longitudinal research is that the time lag between the waves of a study corresponds with the underlying, "true" time lag. If the time lag in the study does not correspond with the true time lag, the effects of the causal variables on the outcomes will be biased. If a particular time lag is shorter than the underlying causal process, it is likely that effects of the causal variable on the effect variable are underestimated (the causal variable will not have fully consummated its impact on the effect variable). If the time lag is too long, it is possible that other processes have influenced the effect variable, implying that the causal effects are biased as well (Taris,

2000). Generally speaking, we have little information about the "right" length of time lags in occupational health research (Dormann & Zapf, 2002; Taris & Kompier, 2003; Zapf et al., 1996). This was clearly demonstrated in De Lange et al.'s (2003) review in which only 7 of 45 longitudinal studies (16%) presented a clear rationale for the time lag that was employed. In addition, there is some diversity in the recommendations made for the appropriate time lag in examining longitudinal relationships between work and health. While Zapf et al. (1996) recommend that the same time lag be used if a study includes more than two measurements, Frese (1984) argues that in such cases processes may be captured better using different time lags. In practice, the length of time lags is often based on the practical facilities of the research project or the time available to the researchers and the participants. Research that compares the results across different time lags is thus clearly needed. Relevant to this issue, Dormann and Zapf (1999) compared findings on the effects of work characteristics on worker well-being for several time lags (4 months, 8 months and 1 year intervals, respectively). When examining the moderating effects of social support by supervisors and colleagues relative to social stressors at work and depressive symptoms they only found effects for an 8-month time lag. Recently, Dormann and Zapf (2002) examined this question more thoroughly in a 4-wave study and found that a time lag of at least 2 years (compared to 4-year time lags) was adequate for examining the relationship between social stressors at work, irritation, and depressive symptoms.

The present study

The present study deals with the issues outlined above in the context of a 4-wave full panel design (1994, 1995, 1996, 1997), providing evidence regarding (i) the nature of the relationships between work characteristics and health, and (ii) the length of the time interval during which the effects of work characteristics on health -or vice versa- occur. As regards the first issue, we examine the following research questions and hypotheses:

1) *Which causal relationship(s) exist(s) between the DCS measures and mental health?*

Considering the significant correlations between the DCS dimensions and various outcomes presented in earlier reviews on the Demand-Control-(Support) model (van der Doef & Maes, 1999; de Lange et al., 2003; Schnall et al., 1994), we expect that there will be a significant lagged relationship between the DCS measures and mental health

(Hypothesis 1). If Hypothesis 1 is retained, the question concerning the nature of the causal process that is responsible for this association becomes salient. We examine three types of causal relationships. First, whether job demands, job control and social support influence mental health over time (normal causal relationships). Second, whether mental health influences job demands, job control and social support (reversed causal relationships). Third, whether job demands, job control, social support and mental health reciprocally influence each other.

De Lange et al. (2003) reviewed 19 high-quality longitudinal studies examining the DCS model and found evidence for normal causal relationships between the dimensions of the DCS model and different health outcomes over time. Consequently, we expect that there will be normal causal relationships between the DCS measures and indicators of mental health across time. Additionally, the research reviewed above also revealed evidence for reversed or reciprocal relationships between work and health. Considering the evidence for both normal and reversed effects found in the aforementioned longitudinal studies, we expect to find reciprocal causal relationships rather than normal or reversed causal relationships only (Hypothesis 2).

This study also examines which time lag between the waves yields the strongest lagged effects of the independent on the outcome variables:

2) *Which time lag shows the strongest results for demonstrating the relationship between the DCS dimensions and mental health across time?*

As Dormann et al. (1999, 2002) found the strongest effects for time lags of 8 months and 2 years, it is expected that a 1-year time lag (i.e., the smallest possible time lag in the present study (versus 2 or 3 years)), will be most appropriate for demonstrating the relationship between the DCS dimensions and mental health (Hypothesis 3).

3.3 Method

Sample. The current study was conducted within the framework of the 4-wave prospective Dutch cohort Study on Musculoskeletal disorders, Absenteeism, Stress and Health (SMASH). At baseline (i.e., 1994), 1789 employees working in 34 different companies, located throughout the Netherlands, participated in this study. These 34 companies were recruited in cooperation with Occupational Health Services and included various industrial and service branches. In order to be included, companies should not have

been involved in major reorganizations during the 3 years of the study, and the pre-study annual turnover rate of their workforce should be lower than 15%. Further, only respondents were selected who had been working for at least one year and more than 20 hours per week in their current job. Blue-collar jobs as well as white-collar jobs and different occupations were selected.

At each wave (i.e., 1994, 1995, 1996 and 1997) the respondents completed a self-administered questionnaire, tapping concepts such as general working conditions, changes in the workplace, psychosocial work characteristics, work satisfaction, physical work load, psychosocial and physical health, and background factors (Ariëns et al., 2001, Hoogendoorn et al., 2000). The data in this study are based on the annual questionnaires measuring psychosocial variables. To ensure valid and reliable results, employees who held a temporary contract and employees receiving a benefit because of (partial) disability were excluded, meaning that 47 of the 1789 respondents were excluded. Further, employees who experienced job changes during the study were excluded, as these transitions may distort the nature of the (normal) causal relationships (N = 1074 at baseline; cf. De Lange et al., 2002). The selected stayers reported no job changes (during the past 12 months), or any changes regarding their colleagues or supervisor(s).

Attrition rate. The response rates were relatively high and varied between 84% (N = 1742) at baseline to 85% (N = 1473) at the third follow-up measurement. Non-response analysis revealed that drop-outs tended to report more strain and less job control across time, a quite common phenomenon (Taris, 2000, for a review). After listwise deletion of missing values, the sample included 668 employees (69% male; average age at baseline was 35.4 years, SD = 8.7; average number of years of employment was 9.8 years, SD = 7.8).

Measures. Job demands. Job demands were measured using a 5-item Dutch translation of Karasek´s (1985) Job Content Questionnaire (e.g., ”My job requires working very fast”, 1 = strongly disagree", 4 = "strongly agree"). The reliability (Cronbach’s alpha) of this scale varied from .65 to .72 across occasions (median = .71).

Job control. Consistent with Karasek's (1985) conceptualisation, job control was measured as the mean of two scales. *Skill discretion* was measured using a 5-item scale (e.g. ”My job requires that I learn new things"), and *decision authority* was measured using a 3-item scale (e.g., “My job allows me to take many decisions on my own”, 1 = "strongly

disagree", 4 = "strongly agree"). The reliabilities of this scale ranged from .81 to .83 (median alpha = .83).

Social support from supervisors. Social support from supervisors was measured using a 4-item Dutch version of Karasek´s (1985) Job Content Questionnaire (e.g., ”My supervisor pays attention to what I say ”, 1 = "strongly disagree", 4 = "strongly agree"). The reliability (Cronbach’s alpha) of this scale varied from .82 to .88 across occasions (median = .86).

Mental health. The current study included three indicators of mental health. (1) *Depression* was measured with an 11-item Dutch version of the CES-D scale (Kohout et al., 1993; Radloff, 1977). This scale taps symptoms of depressive mood (e.g., "The past two weeks I felt lonely", 1 = "hardly ever or never", 2="sometimes", 3 = "much or most of the time"). The reliability varied from .81 to .87 (median alpha = .85). (2) *Job satisfaction* was measured by a single item ("Do you enjoy your work?", 1 = "(almost) never", 4 = "(almost) always"). A meta-analysis of Wanous et al. (1997) demonstrated that single-item measures of job satisfaction are usually highly correlated with multi-item scales. (3) *Emotional exhaustion* was measured by a 7-item dichotomous subscale of the Maslach Burnout inventory (Schaufeli & Van Dierendonck, 1993, e.g., “I feel emotionally drained from my work”, 0 = "no", 1 = "yes"). The reliability varied from .72 to .78 (median alpha =.77).

Covariates. Age and gender were used as covariates in the analysis. These variables are often related to the outcome variables employed in this study. Failing to control for these variables may result in bias in the effects of other variables (e.g., de Jonge & Kompier, 1997; Karasek & Theorell, 1990; Schnall et al., 1994). In preliminary analyses we also controlled for level of education and years of experience in the present job. These variables were not included further as preliminary analyses revealed that these were not substantially related ($p > .05$) to the outcome variables.

Statistical analysis. Correlational analyses were conducted to obtain more basic insight into the data. Structural equation modeling (SEM; Jöreskog & Sörbom, 1993) was used to test and compare various competing models for the relationships among demands, control and social support of supervisors and indicators of mental health across time. SEM has the advantage of providing global measures of fit for latent variable models (Brannick, 1995). In the present research we performed a comparative analysis in which the fit of several competing models was assessed to determine which model fitted the data best (Kelloway, 1998). All model tests were based on the covariance matrix and maximum likelihood

estimation. A non-significant or small chi-square value indicates that the model fits the data well. However, in large samples even small and substantively unimportant differences between the estimated model and the "true" underlying model will result in rejection of the model that is tested (Bentler & Chou, 1987). Therefore, we also considered other indices in judging the fit of our models, including the goodness-of–fit index (GFI: based on a ratio of the squared discrepancies to the observed variances; Jöreskog & Sorbom, 1993), the non-normed fit index (NNFI: represents the increase in fit when comparing any hierarchical step-up comparison of two models; Bentler & Bonett, 1980) and the root-mean square error of approximation (RMSEA: based on the analysis of the residuals; Jöreskog & Sorbom, 1993). Levels of .90 or better for GFI and NNFI and levels of .05 or lower for RMSEA indicate that models fit the data reasonably well (Byrne, 2002).

Considering the problems caused by estimating all observed items and latent variables (insufficient power and under-identification, Bentler & Chou, 1987; Schumacker & Lomax, 1996), we assumed the scale and latent variables to be identical. However, following the two-step approach proposed by James, Mulaik and Brett (1982) we first tested the measurement models for each of the variables before fitting the structural models. These analyses showed that the factor structures of the research variables were consistent across time. Finally, all results presented below are based on the standardised results from the covariance matrices of the variables.

Competing structural models. To examine the causal relationships between the DCS dimensions and indicators of mental health we tested a baseline model versus several competing nested models. These models were:

(1) *Baseline model (*M_0): Includes temporal stabilities and synchronous (i.e., within-wave) effects of variables over time and controls for the influence of covariates (age and gender). This model is used as the reference model.

(2) *Normal causation model* (M_1): This model resembles M_0, but includes additional cross-lagged structural paths from the Time 1, Time 2 and Time 3 DCS dimensions to Time 2, Time 3 and Time 4 mental health (depression, job satisfaction and emotional exhaustion; see Figure 3.1).

(3) *Reversed causation model* (M_2): This models resembles M_0, but is extended with cross-lagged structural paths from Time 1, Time 2 and Time 3 mental health (depression, job satisfaction and emotional exhaustion) to Time 2, Time 3 and Time 4 DCS dimensions.

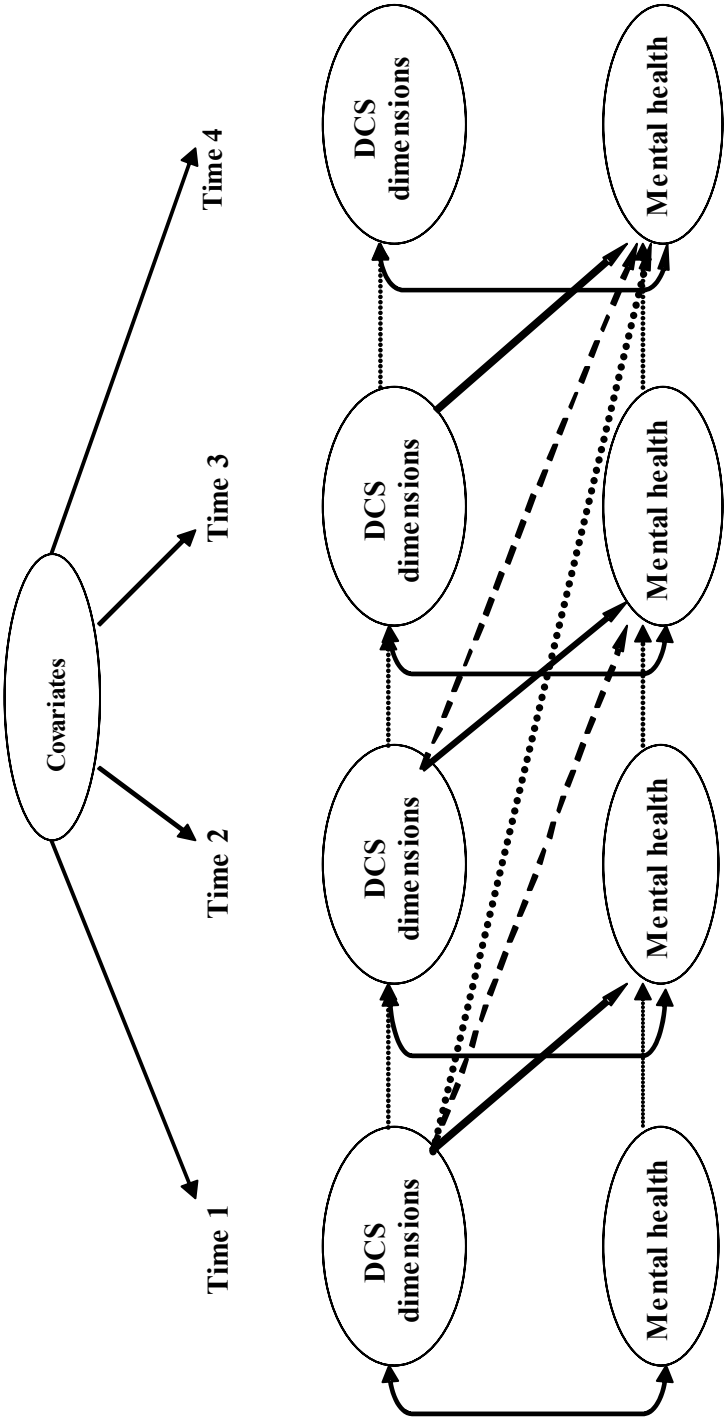


Figure 3.1

Normal causal relationship model (M_1) with different time lag effects

Note. ——▶ : 1-year effects; ▬ ▬ ▶ : 2-year effects; ·····▶ : 3-year effects; DCS dimensions= job demands, control and social support of supervisor; indicators of mental health are: depression, job satisfaction and emotional exhaustion.

Reciprocal causation model (M_3): This model resembles M_0, but includes additional reciprocal cross-lagged structural paths from the DCS dimensions on well-being and vice versa (i.e., the normal paths included in model M_1 as well as the reversed paths included in model M_2).

Three additional models (M_4-M_6) tested whether the structural cross-lagged paths presented in models M_1-M_3 were the same for corresponding time intervals. That is, the effects for all 1-year intervals (Time 1 to Time 2, Time 2 to Time 3, and Time 3 to Time 4) were assumed to be the same; and the same was assumed for the two-year intervals (Time 1 to Time 3 and Time 2 to Time 3). Model M_4 is identical to M_1, save that the same-length lagged effects are constrained to be equal; model M_5 corresponds with M_2; and M_6 corresponds with M_3. This strategy allows us to test whether the results presented across the same time lags are consistent or that the strength of effects varies across time.

3.4 Results

Correlational analyses Table 3.1 presents the means, standard deviations, and correlations between the different measures. Correlations between the measures were in the expected direction. As regards the across-time stability of these variables, the Time 1-Time 2 test-retest correlations ranged from .49 (for Depression) to .67 (for Control: median correlation was .55, all *p*'s < .001); the Time 2-Time 3 test-retest correlations ranged from .56 (for Social support supervisor) to .68 (for Control: median correlation was .61; all *p*'s < .001); the Time 3-Time 4 test-retest correlations ranged from .49 (Social Support) to .71 (Control; median correlation was .60; all *p*'s < .001). Although these correlations are substantial, there is quite some across-time variation in the variables included in this study. E.g., even a Time 3-Time 4 correlation as high as .71 for Control implies that both measures share no more than 50% of their variance.

Table 3.1

Correlations, means and standard deviations for the study variables (N= 668)

Variables	***M***	***SD***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1 Age	35.93	8.71	1.0										
2 Sex[a]	1.31	.46	-.14	1.0									
3 Dem T1	2.60	.46	.03	.01	1.0								
4 Dem T2	2.52	.49	.02	.01	.56	1.0							
5 Dem T3	2.64	.49	.03	.00	.53	.62	1.0						
6 Dem T4	2.58	.47	.04	.01	.51	.58	.64	1.0					
7 Cont T1	2.81	.50	.11	-.21	-.04	-.02	-.06	.02	1.0				
8 Cont T2	2.86	.48	.11	-.16	.00	-.04	-.06	.03	.67	1.0			
9 Cont T3	2.86	.46	.11	-.18	-.08	-.06	-.09	-.02	.63	.68	1.0		
10 Cont T4	2.84	.48	.08	-.20	-.05	-.06	-.08	.01	.64	.67	.71	1.0	
11 Sup T1	2.73	.55	.06	.03	-.18	-.10	-.13	-.13	.25	.18	.18	.18	1.0

Note: [a] 0 = female and 1 = male. NB. correlations of .05 and over are significant at $p < .05$; Dem = Job demands; Cont = Control; Sup = Social Support; Dep = Depression; Sat= Job satisfaction; Emo= Emotional Exhaustion. T1/T2/T3/T4 refer to Time 1, Time 2, Time 3 and Time 4, respectively.

-Table 3.1 continued-

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
12 Sup T2	2.66	.58	.04	.05	-.11	-.21	-.16	-.16	.13	.30	.21	.21	.51	1.0								
13 Sup T3	2.64	.58	.07	.04	-.14	-.18	-.24	-.21	.13	.18	.23	.18	.47	.56	1.0							
14 Sup T4	2.62	.59	.01	.04	-.16	-.20	-.20	-.25	.21	.24	.24	.34	.41	.52	.49	1.0						
15Dep T1	1.26	.27	-.04	.13	.12	.13	.09	.14	-.17	-.16	-.13	-.16	-.08	-.11	-.14	-.16	1.0					
16 Dep T2	1.29	.29	-.02	.11	.12	.18	.18	.17	-.13	-.19	-.14	-.14	-.11	-.16	-.16	-.12	.49	1.0				
17 Dep T3	1.32	.32	-.04	.21	.11	.17	.12	.17	-.14	-.15	-.17	-.17	-.06	-.12	-.15	-.12	.41	.59	1.0			
18 Dep T4	1.32	.33	-.02	.15	.08	.15	.10	.17	-.10	-.15	-.18	-.21	-.04	-.13	-.13	-.10	.41	.50	.57	1.0		
19 Sat T1	3.37	.70	.04	.10	-.08	-.06	-.09	-.08	.26	.26	.22	.20	.23	.16	.15	.13	-.18	-.21	-.17	-.20	1.0	
20 Sat T2	3.33	.72	.04	.10	-.04	-.14	-.11	-.04	.25	.37	.27	.25	.21	.31	.23	.16	-.24	-.32	-.23	-.21	.53	1.0

Note: Correlations of .05 and over are significant at $p < .05$; Dem = Job demands; Cont = Control; Sup = Social Support; Dep = Depression; Sat= Job satisfaction; Emo= Emotional Exhaustion. T1/T2/T3/T4 refer to Time 1, Time 2, Time 3 and Time 4, respectively.

-Table 3.1 continued-

Var	*M/ SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
21 SatT3	3.3/ .73	.07	.07	-.09	-.13	-.13	-.11	.26	.31	.35	.31	.22	.23	.33	.16	-.17	-.26	-.26	-.27	.52	.58	1.0				
22 SatT4	3.3/ .74	.09	.05	-.07	-.12	-.12	-.16	.27	.30	.30	.35	.18	.26	.21	.22	-.23	-.30	-.29	-.34	.49	.56	.62	1.0			
23 EmT1 o	.15/ .17	-.01	.03	.40	.31	.32	.31	-.14	-.12	-.14	-.11	-.16	-.15	-.15	-.09	.32	.34	.27	.27	-.27	-.24	-.21	-.24	1.0		
24 EmT2 o	.14/ .18	-.02	.01	.29	.41	.33	.32	-.09	-.18	-.14	-.14	-.12	-.23	-.18	-.09	.33	.50	.35	.30	-.23	-.37	-.23	-.28	.58	1.0	
25 EmT3 o	.14/ .18	.00	.03	.30	.36	.46	.34	-.11	-.13	-.16	-.13	-.16	-.22	-.24	-.11	.29	.37	.39	.33	-.22	-.30	-.32	-.31	.53	.62	1.0
26 EmT4 o	.13/ .18	.02	.03	.29	.36	.37	.46	.01	-.05	-.11	-.11	-.12	-.21	-.25	-.07	.28	.36	.32	.46	-.16	-.17	-.21	-.32	.49	.56	.58

Note: Correlations of .05 and over are significant at $p < .05$; Dem = Job demands; Cont = Control; Sup = Social Support; Dep = Depression; Sat= Job satisfaction; Emo= Emotional Exhaustion. T1/T2/T3/T4 refer to Time 1, Time 2, Time 3 and Time 4, respectively.

Table 3.2

Fit indices for the stability model versus the nested (competing) causal structural models

Model	χ^2	*df*	NNFI	GFI	RMSEA
M_0 Baseline model	393.44	180	.95	.95	.043
M_1 Normal causality	253.88	126	.95	.97	.040
M_2 Reversed causality	316.29	126	.93	.96	.048
M_3 Reciprocal causality	180.56	72	.93	.98	.048
M_4 Normal + equal relationships over time	288.29	153	.96	.97	.037
M_5 Reversed + equal relationships over time	340.75	153	.94	.96	.043
M_6 Reciprocal + equal relationships over time	240.54	126	.96	.97	.037
M_7 M_6+ equal normal and reversed relationships	290.44	153	.96	.97	.037

Note. All chi-square values significant at $p < .001$; coefficients and numbers refer to model fit indices: χ^2, NNFI = Non-normed fit index, GFI = Goodness-of-fit index, RMSEA = Root-mean square error of approximation.

Question 1: Which causal relationship(s) exist(s) between the DCS measures and mental health? In order to answer question 1, the results of the six competing structural models described in the Method (M_0-M_6) were compared. Table 3.2 presents the fit indices for these models. The fit of all models was satisfactory (NNFI, GFI $\geq .90$ and RMSEA $\leq .05$). Further, we tested whether models M_1-M_6 fitted the data significantly better than the baseline model (Table 3.3). Relevant to question 1, this analysis shows whether a model including relationships between work and health shows a better fit than a model without these relationships.

Table 3.3

Chi-square difference tests of different structural models

Model		$\Delta\chi^2$	Δdf
	Comparison with M_0		
M_0 versus M_1	Baseline model versus Normal causality model	139.56**	54
M_0 versus M_2	Baseline model versus Reversed causality model	77.15*	54
M_0 versus M_3	Baseline model versus Reciprocal causality model	212.88**	108
M_0 versus M_4	Baseline model versus Normal + equal relationships model	105.15**	27
M_0 versus M_5	Baseline model versus Reversed + equal relationships model	52.69*	27
M_0 versus M_6	Baseline model versus Reciprocal + equal relationships model	152.90**	54
	Equal Time lag effects?		
M_1 versus M_4	Normal causality model versus Normal + equal relationships model	34.41	27
M_2 versus M_5	Reversed causality model versus Reversed + equal relationships model	24.46	27
M_3 versus M_6	Reciprocal causality model versus Reciprocal + equal relationships model	59.98	54

Note. * = $p < .05$, ** = $p < .001$; $\Delta\chi^2$ = difference in chi-square values; Δdf = difference in degrees of freedom

The chi-squared difference tests in Table 3.3 show that M_1-M_6 all fit the data significantly better than the baseline model. Thus, there are longitudinal relationships between the DCS dimensions and mental health (Hypothesis 1 confirmed). To determine whether these relationships were consistent across time, we computed three additional chi-square difference tests that compared models M_1-M_3 to the corresponding models M_4-M_6 (Table 3.3). These tests revealed that the differences between the constrained models M_4-M_6 and their unconstrained counterparts M_1-M_3 were non-significant. Considering these non-significant results and the relatively better incremental fit indices for M_4-M_6 (cf. Table

3.2), we concluded that the cross-lagged structural patterns did not vary across time. Further analyses were therefore based on M_4-M_6.

As regards the type of relationships between work and health (i.e, only normal effects, only reversed effects, or reciprocal causal relationships), we compared the fit of different models corresponding with these notions (Models M_4, M_5 and M_6, respectively). The results confirmed Hypothesis 2: the reciprocal model (M_6) accounted best for the data, relative to the normal causation model (M_4 versus M_6: $\Delta\chi^2$ (27, N = 668) = 47.75, $p < .05$) and the reversed causation model (M_5 versus M_6: $\Delta\chi^2$ (27, N = 668) = 100.21, $p < .05$).

As to this bi-directional relationship, the question remains which relation is causally dominant: the normal or the reversed pattern? To this aim, we tested the equality of the normal and reversed cross-lagged patterns (Model M_7). The chi-squared difference between the models with and without equality constraints was significant (M_6 versus M_7: $\Delta\chi^2$ (27, N = 668) = 49.90, $p < .05$). Consequently, the normal and the reversed cross-lagged patterns are unequal; one is causally predominant. The fit indices of the normal (M_4) and reversed (M_5) causation model (cf. Table 3.2) show that the normal causation model fits the data better than the reversed causation model. This suggests that the normal cross-lagged effects are dominant compared to the reversed effects, an impression that was confirmed by inspection of the parameter estimates in these models.

Which time lag shows the strongest results for demonstrating the relationship between the DCS dimensions and mental health across time (Question 2)? A 'Knight's move'. Our analyses suggest that work and mental health mutually influence each other. However, before the final model is obtained we must take an additional step. Just like the Knight's move in chess consists of two steps, a follow-up analysis to those presented above may yield more insight into the question which time lag or combination of time lags shows the best fit, i.e., across which time span the processes studied here operate. Our 4-wave panel study allows for examining the effects of three time lags (1, 2 and 3 years).

For this follow-up analysis six additional models were tested. The reciprocal causal model that was evaluated as the best model in step 1 was used as the baseline model (M_6 in Table 3.4). The other models specified reciprocal relationships across a time lag of 1 year only (M_8), across 2 years only (M_9) or across 3 years only (M_{10}). Further, combinations of these time lags were examined (M_{11}: a combination of 1 and 2 year intervals, M_{12}: a combination of 1 and 3 year intervals; and M_{13}: a combination of 2 and 3 year intervals).

The fit indices of these models in Table 3.4 revealed that all models fitted the data reasonably well (GFI, NNFI > .90 and RMSEA < .05).

Table 3.4

Fit indices for different structural nested models (based on different time lags)

Model		χ^2	*df*	NNFI	GFI	RMSEA
M_6	Baseline model, reciprocal relationships that are constrained across time	240.54	126	.96	.97	.037
M_8	Reciprocal model/ 1-year time lag	283.75	162	.97	.97	.034
M_9	Reciprocal model/ 2-year time lag	334.51	162	.95	.96	.040
M_{10}	Reciprocal model/ 3-year time lag	359.79	162	.94	.96	.044
M_{11}	Reciprocal model/ 1 + 2-year time lags	262.13	144	.96	.97	.035
M_{12}	Reciprocal model/ 1 + 3-year time lags	262.75	144	.96	.97	.035
M_{13}	Reciprocal model/ 2+3-year time lags	312.59	144	.95	.96	.042

Note. All chi-square values significant at $p < .001$; NNFI = Non-normed fit index, GFI = Goodness of fit index, RMSEA = Root-mean square error of approximation.

Table 3.5 shows that only the models with 1-year cross-lagged paths (M_8), the combination of 1 and 2 year intervals (M_{11}) and the combination of 1 and 3 year intervals (M_{12}) fit the data about equally well as the reference model M_6, as evidenced by non-significant increases in chi-square values. Thus, models M_8, M_{11} and M_{12} present the same fit to the data compared to the baseline model, whereas the other models fit the data significantly worse. As parsimonious models (i.e., models with relatively few parameters) should be preferred to more complex models with the same fit (Kelloway, 1998), the model that only specified the relationships across a 1-year time lag (M_8) was chosen as the best-fitting model. Figure 3.2 presents the final model with the significant standardised cross-

lagged structural paths. Note that these effects were constrained to be equal across all 1-year time intervals (i.e., the effects presented in Figure 3.2 apply to the Time 2-Time 3 and Time 3-Time 4 intervals as well).

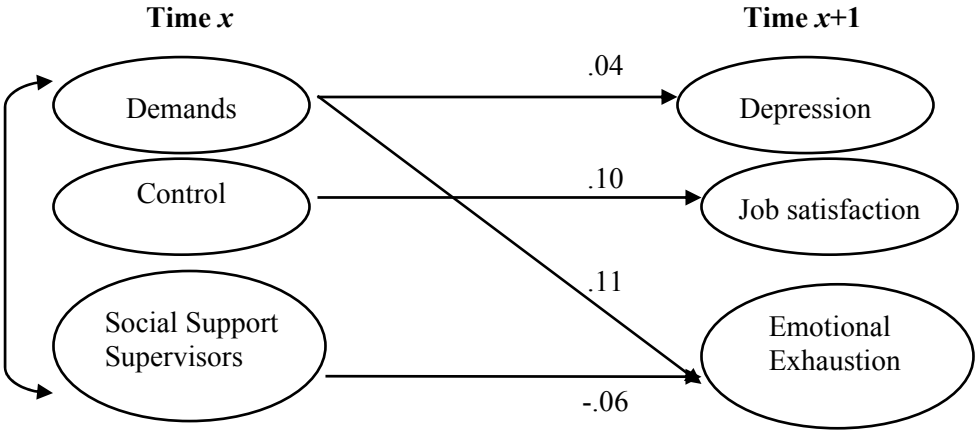
Table 3.5

Chi-square difference tests of different structural models (based on different time lags)

Model		$\Delta\chi^2$	Δdf
	Comparison with M_6		
M_6 versus M_8	Baseline Reciprocal causal model versus Reciprocal model/1-year time lag	43.12	36
M_6 versus M_9	Baseline Reciprocal causal model versus Reciprocal model/2-year time lag	93.97*	36
M_6 versus M_{10}	Baseline Reciprocal causal model versus Reciprocal model/3-year time lag	119.25*	36
M_6 versus M_{11}	Baseline Reciprocal causal model versus Reciprocal model/1+2-year time lag	21.59	18
M_6 versus M_{12}	Baseline Reciprocal causal model versus Reciprocal model/1+3-year time lag	22.21	18
M_6 versus M_{13}	Baseline Reciprocal causal model versus Reciprocal model/2+3-year time lag	72.05*	18
	Comparison with M_8, M_{11}, M_{12}		
M_8 versus M_{11}	Reciprocal model/1-year time lag versus Reciprocal model/1+2-year time lag	21.62	18
M_8 versus M_{12}	Reciprocal model/1-year time lag versus Reciprocal model/1+3-year time lag	21	18

Note. * = $p < .001$; $\Delta\chi^2$ = difference in chi-square values (of for instance M_0 versus M_1); Δdf = difference in degrees of freedom (of for instance M_0 versus M_1)

Normal cross-lagged effects



Time lag =1 year

Reversed cross-lagged effects

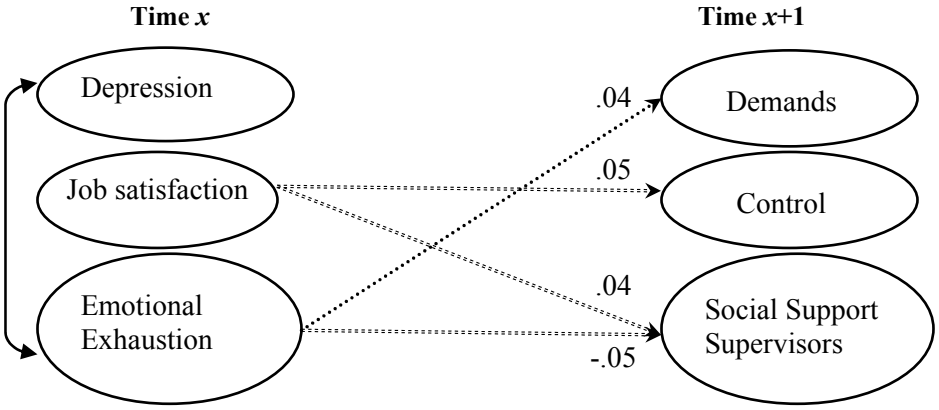


Figure 3.2

Reciprocal causal relationships between work and health based on a time lag of 1 year

Note. Standardised effects are presented (after controlling for covariates); stability effects not shown; R^2= total amount of variance of specific variable explained by the model. R^2 for demands: 32% on T2, 43% on T3, 47% on T4; R^2 for control: 46% on T2, 52% on T3, 58% on T4; R^2 for social support: 26% on T2, 35% on T3, 33% on T4; R^2 for depression: 19% on T2, 36% on T3, 34% on T4; R^2 for job satisfaction: 27% on T2, 39% on T3, 45% on T4; R^2 for emotional exhaustion: 28% on T2, 41% on T3, 39% on T4.

Figure 3.2 presents evidence for normal as well as reversed relationships. Time 1 job demands influence Time 2 depression (β = .04, $p < .05$) and emotional exhaustion (β = .11, $p < .05$). These effects show that an increase in job demands is related to an increase in depression and emotional exhaustion across time. In addition, Time 1 social support of supervisors influences Time 2 emotional exhaustion (β = -.06, $p < .05$). An increase in social support of supervisors is related to a decrease in levels of emotional exhaustion across time. Furthermore, Time 1 job control influences Time 2 job satisfaction (β = .10, $p < .05$); an increase in job control is related to an increase in job satisfaction across time.

The reversed relationships were somewhat weaker than the normal relationships. Reversed effects were found from Time 1 Job satisfaction to Time 2 job control (β = .05, $p < .05$) and Time 2 social support of supervisors (β= .04, $p < .05$), and from Time 1 emotional exhaustion to Time 2 job demands (β = .04, $p < .05$) and Time 2 social support of supervisors (β = -.05, $p < .05$). Thus, an increase in Time 1 job satisfaction is related to an increase in Time 2 job control and Time 2 social support of supervisors across time, whereas an increase in Time 1 emotional exhaustion results in an increase of Time 2 job demands and decrease of Time 2 social support of supervisors.

3.5 Discussion

Considering the paucity of longitudinal studies that explicitly examine different types of causal relationships and the potential impact of different time lags on the results, we addressed these issues in a 4-wave panel study. We explored different causal relationships between the DCS dimensions and indicators of mental health with 1-year, 2-year and 3-year (combinations of) time lags. The results revealed that there were cross-lagged relationships between the DCS dimensions and mental health (Hypothesis 1 confirmed). Furthermore, evidence was found for reciprocal causal relationships between the DCS dimensions and indicators of mental health (Hypothesis 2 confirmed). The strongest effects were found for a 1-year time lag (Hypothesis 3 confirmed), whereas the effects of job characteristics on health were stronger than the reverse effects. This pattern of results underscores the importance of job demands, job control and social support of supervisors in the development of mental health across time. Consequently, these results also support the causal ordering of these work characteristics in well-known work stress models such as the Demand-Control-Support model (Karasek & Theorell, 1990).

In line with earlier longitudinal research (among others, de Jonge et al., 2001; Leiter & Durup, 1996), reciprocal relationships were found for the relationship between job demands, social support of supervisors and emotional exhaustion. Furthermore, we found reciprocal relationships between job control and job satisfaction. In other words, consistently normal as well as reversed cross-lagged effects were found across the waves of our study.

How can the reversed effects found in this study be explained? As mentioned in the introduction, the available literature (Zapf et al., 1996; Spector et al., 2000) provides only a few clues with respect to the mechanisms that may account for reversed causation. Following Zapf et al. (1996) and Spector et al. (2000), we believe that reversed effects of mental health can be due to two basic mechanisms. First, *real* changes in one´s work environment may occur due to one´s mental health status. For example, it seems plausible that healthy workers have a better chance of getting promoted or finding a better job than other workers; all other factors being equal, few employers will consider a depressed job applicant more fit for the job than his or her non-depressed competitors (cf. Taris, 1999; Zapf et al., 1996). Reported changes in job characteristics across time may thus relate to the change from the current to a new job, but may also occur within the current job. Examples of such within job changes are more support or more interesting tasks for healthier employees (those with a higher coping capacity). As this study only included employees who did not experience job changes (or changes in their colleagues or supervisors) across time, this type of explanation seems less plausible here.

The last mechanism focuses on changes in the *evaluation* of the *same* work environment (i.e., the person's perception of the same working conditions changes as a result of their mental health status). For instance, the reversed effect of emotional exhaustion on demands and social support may be explained by assuming that the more fatigued employees perceive their work environment more *negatively* over time. As a consequence, the relatively unhealthy workers report higher job demands and lower levels of supervisor social support across time. Zapf et al. (1996) termed this negative re-interpretation effect the "true strain-stressor process", whereas Spector et al. (2000) introduced the "stressor creation hypothesis" (in the context of negative affectivity). One might say that these explanations all draw on the assumption that relatively unhealthy workers are apt to perceive their work environment in an increasingly *gloomy* fashion.

Alternatively, the reversed effect of job satisfaction on job control might be explained by positive re-evaluation effects. One may assume that the satisfied workers colour their perceptions of the work characteristics more rosy (*rosy* perception mechanism), meaning that they will perceive more job control across time (Fletcher, 2003). Either, both or none of these two mechanisms may apply and we believe that occupational health psychology would benefit from clever thinking (theory) and from innovative empirical studies towards these mechanisms (Taris & Kompier, 2003).

Study limitations. At least two limitations of our study need to be discussed. First, the best fitting structural model (see Figure 2) showed relatively low standardised regression coefficients. Hence, relatively little variance in the outcomes is accounted for in this study. However, according to Semmer, Zapf, and Greif (1996), small standardised effects are to be expected as they argue that there is an upper limit of 15 to 20 percent variance in strain that can be explained by job stressors. Moreover, it is important to note that the cross-lagged effects of, for instance, job demands on emotional exhaustion refer to predicting *change*s in emotional exhaustion from time 1 to time 2 (i.e. after controlling for Time 1-Time 2 stability effects). By definition these effects will be small, as many phenomena will be relatively stable across the 1-year time interval employed in this study. Thus, the small effects found in this study are common in longitudinal research. Further, we should not underestimate the cumulative effects of these relationships across time. Just like drops of water may dent a stone in time, the small effects found in our research may accumulate, possibly resulting into severe health complaints across time.

Second, this study is based on survey data. One problem of using survey data only is the risk of self-report bias, e.g. due to personality traits such as negative affectivity (Schnall et al., 1994). By combining self-report measures with "objective" measures researchers can mitigate the effects of methodological and/or conceptual overlap between the measured variables, thus reducing the risk of falling in the “triviality trap” (Kasl, 1978; Kristensen, 1996). On the other hand Spector (1992), in a meta-analysis, has shown that the variance in self-report measures of job conditions can largely be attributed to variations in the objective work environment. Based on the work of Spector (1992) and Semmer and co-workers (1996, p. 304) we argue that results from self-report data “may be better than is often assumed” and that the discussion about self-report data versus “objective” measures is not very constructive. Nevertheless, the impact of common method variance should be further

examined in future research. For example, Lindell and Whitney (2001) describe a potentially interesting method that can be used for testing these effects.

Study implications. In spite of these limitations, we feel that the present study has both important practical and scientific implications. The most important practical lesson that follows from the more dominant normal causal relationship between the DCS characteristics and mental health is that interventions directed at decreasing job demands, and increasing job control or social support of supervisors may improve the mental health of employees (see also Semmer, 2003; Kompier, 2004). However, the reciprocal relationships found between work and mental health indicate that, in general, professionals in the field of work and organisational psychology should bear in mind that well-being may affect work characteristics as well.

Scientifically, our results revealed that the associations between work characteristics and health should not be construed as the result of a one-directional process in which work characteristics influence health. Although for those employees who stay in the same type of work ('stayers') this normal causal process seems to be the most prominent, our results appear to confirm earlier findings that health also influences workers' job conditions. The results of this study thus indicate that the one-directional view in the original DCS model and similar models may be too narrow. Karasek and Theorell (1990, p. 99) also underscored the importance of using a broader perspective for the relationship between work and health and proposed a dynamic version of the Demand-Control model, which integrates environmental effects with person-based information (such as self-esteem). Our results seem to be consistent with this dynamic view in which work has effects on strain levels of the employee, but in which it is also possible that health indicators influence work characteristics.

From this study we may derive four recommendations for future (longitudinal) research:

1 *Investigate different causal relationships*. Our study provided evidence for reciprocal causal relationships. We recommend that future research not only examines normal, but also reversed and reciprocal causal relationships between (the same and other) job characteristics and indicators of well-being. Such research may reveal to which degree the present results generalize to other settings (Rothman & Greenland, 1998).

2 *Explore multiple outcomes.* In our study we utilized job satisfaction, depression and emotional exhaustion as indicators of mental health. More research that focuses on different, preferably objective outcome variables is needed. Such research may also enhance our understanding of the degree to which common method variance has affected our (and previous) results. In addition, future research might explore in more detail the strength of across-time relations as a function of the type of outcome variable.

3 *Employ similar and different time lags.* The results from this study indicated that a 1-year time lag is appropriate for demonstrating the causal relationships between the DCS dimensions and the indicators of mental health employed in this study. On the other hand, in the studies of Dormann et al. (1999; 2002) evidence was found for a time lag of 8 months and of 2 years when examining the moderating effects of social support by supervisors and colleagues in the context of the effects of social stressors at work on depressive symptoms. More longitudinal research is needed to replicate these results and to test other (especially shorter) time lags (cf. Hoogendoorn et al., 2002). We believe that the preferable length of time lag(s) will depend on the type of outcome being measured, the amount of exposure to the stressors of interest, and whether or not changes in work characteristics or job changes have taken place. It is important that the time lag suits the process and aetiology of the relationships between the research variables over time.

4. *Formulate and test different theoretical explanations for reciprocal relationships between work and health.* More and better explanations are needed for reversed or reciprocal causal relationships. The aforementioned explanations provided by Zapf et al. (1996) and the dynamic version of Karasek and Theorell's (1990) Demand-Control model only provide first steps towards a fuller understanding of reverse causation processes. One important factor in such additional theorizing will be the nature of across-time changes in work characteristics. Such changes may be based on either *real* or *perceived* changes. In this paper we tried to control for the effects of major job changes by restricting our data to participants who did not change jobs (or experienced any changes in their colleagues or supervisors) during the study interval, suggesting that most of the changes in the work characteristics that occurred in this study refer to changes in the perceptions of these characteristics. However, in order

to test reversed effects resulting in *real* changes of the environment it is important to examine a response group with job changes across time as well (see de Lange et al., 2005). Further theorizing on the possible effects of health on work characteristics will definitely enhance our understanding of the reversed or reciprocal effects between work and health.

Acknowledgements.

This study was partly supported by the Dutch Ministry of Social Affairs and Employment, and Ministry of Public Health, Welfare, and Sports; and the Dutch National Institute for Social Security. The first author thanks Professor Peter Molenaar (University of Amsterdam) for checking some of our SEMs, and Femke de Lange for valuable discussions on earlier drafts of this paper.

References

Ariëns, G.A.M., Bongers, P. M., Miedema, M.C., Wal, G., van der, Bouter, L.M., Mechelen, W. van (2001). Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study in occupational setting. *Journal of Occupational and Environmental Medicine*, *58*, 200-207.

Bakker, A.B., Schaufeli, W.B., Sixma, H.J., Bosveld, W., & Dierendonck, D. van (2000). Patient demands, lack of reciprocity and burnout: A five-year longitudinal study among general practitioners. *Journal of Organizational Behavior, 21*, 425-441.

Belkić, K., Landsbergis, P.A., Schnall, P.L., & Baker, D. (2004). Is job strain a major source of cardiovascular disease risk? *Scandinavian Journal of Work, Environment and Health, 30,* 85-128.

Bentler, P.M. & Bonett, D.G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, *88*, 588-606.

Bentler, P.M., & Chou, C.P. (1987). Practical issues in structural equation modelling. *Sociological Methods and Research, 16*, 78-117.

Brannick, M. T. (1995). Critical comments on applying covariance structure modelling. *Journal of Organizational Behavior, 16,* 201-213.

Bollen, K.A. (1989). *Structural equation modelling with latent variables*. New York: Wiley.

Byrne, B.M. (2002). *Structural equation modeling with AMOS*. Mahwah, NJ: Lawrence Erlbaum.

Doef, M.P. van der, & Maes, S. (1999). The Job Demand-Control(-Support) Model and psychological well-being: A review of 20 years of empirical research. *Work & Stress, 13,* 87-114.

Dormann, C., & Zapf, D. (1999). Social support, social stressors at work, and depressive symptoms: Testing for main and moderating effects with structural equations in a three-wave longitudinal study. *Journal of Applied Psychology, 84*, 874-884.

Dormann, C., & Zapf, D. (2002). Social stressors at work, irritation, and depressive symptoms: Accounting for unmeasured third variables in a multi-wave study. *Journal of Occupational and Organizational Psychology, 75*, 33-58.

Fletcher, B.C. (2003). A fit approach to work stress and health. In M. J. Schrabracq, J.A.M. Winnubst & C.L. Cooper (Eds.), *The handbook of work & health psychology* (pp. 549-568). John Wiley & Sons Ltd, England.

Frese, M. (1984). Job transitions, occupational socialisation and strain. In V. Allen & E. van de Vliert (Eds), *Role transitions.* New York: Plenum Press.

Frese, M., & Zapf, D. (1988). Methodological issues in the study of work stress: Objective vs subjective measurement of work stress and the question of longitudinal studies. In C.L. Cooper and R. Payne (Eds.), *Causes, coping and consequences of stress at*

work (pp. 375-411). Chichester: John Wiley & Sons Ltd.

Hoogendoorn, W.E., Bongers, P.M., Vet, H.C.W. de, Douwes, M., Koes, B.W., Miedema, M.C., Ariëns, G.A.M., & Bouter, L.M. (2000). Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: Results of a prospective cohort study. *Spine, 25*, 3087-3092.

Hoogendoorn, W.E., Bongers, P.M., Vet, H.C.W. de, Twisk, J.W.R., Mechelen, W. van, & Bouter, L.M. (2002). Comparison of two different approaches for the analysis of data from a prospective cohort study: an application to work-related risk factors for low back pain. *Occupational and Environmental Medicine, 59*:459-465

Hurrell, J.J., Nelson, D.L., & Simmons, B.L. (1998). Measuring job stressors and strains: Where we are, and where we need to go. *Journal of Occupational Health Psychology, 3*, 368-389.

James, L.R., Mulaik, S.A., & Brett, J.M. (1982). *Causal analysis: Assumptions, models and data*. Beverly Hills, CA: Sage.

Johnson, J.V., & Hall, E.M. (1988). Job strain, work place social support, and cardiovascular disease: A cross-sectional study of a random sample of the Swedish working population. *American Journal of Public Health, 78,* 1336-1342.

Jonge, J. de, Dormann, C., Janssen, P.P.M., Dollard, M.F., Landeweerd, J.A., & Nijhuis, F.J.N. (2001). Testing reciprocal relationships between job characteristics and psychological well-being: A cross-lagged structural equation model. *Journal of Occupational and Organizational Psychology, 74,* 29-46.

Jonge, J. de, & Kompier, M.A.J. (1997). A critical examination of the Demand-Control-Support Model from a work psychological perspective. *International Journal of Stress Management, 4*, 235-258.

Jöreskog, K.G., & Sörbom, D. (1993). *Lisrel-8 (user's manual).* Chicago: Scientific Software.

Karasek, R.A. (1985). *Job Content Instrument: Questionnaire and user's guide*. Los Angeles: Department of Industrial and Systems Engineering, University of Southern California.

Karasek, R., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life.* New York: Basic Books.

Kasl, S.V. (1978). Epidemiological contributions to the study of work stress. In C. L. Cooper and R. Payne (Eds.), *Stress at work* (pp. 3-48). New York, Wiley.

Kelloway, K.E. (1998). *Using lisrel for structural equation modeling: A researcher's guide*. London: Sage publications.

Kessler, R.C., & Greenberg, D.F. (1981). *Linear panel analysis: Models of quantitative change*. New York: Academic Press.

Kohn, M.L., & Schooler, C. (1982). Job conditions and personality: A longitudinal assessment of their reciprocal effects. *American Journal of Sociology, 87*, 1257-

1286.

Kohout, F. J., Berkman, L. F., Evans, D. A., Cornoni-Huntley, J. (1993). Two shorter forms of the CES-D depression symptoms index. *Journal of Aging and Health, 5,* 179-193.

Kompier, M. A. J., & Taris, T. W. (2004). Assessing methodological quality and biological plausibility in occupational health psychology. *Scandinavian Journal of Work, Environment and Health, 30*, 81-84.

Kristensen, T.S. (1996). Job stress and cardiovascular disease: A theoretical critical review. *Journal of Occupational Health Psychology, 3,* 246-260.

Lange, A.H. de, Taris, T.W., Kompier, M.A.J., Houtman, I.L.D., & Bongers, P.M. (2002). The effects of stable and changing demand-control histories on worker health: Results of the longitudinal SMASH study. *Scandinavian Journal of Work, Environment and Health, 28*, 94-108.

Lange, A.H. de, Taris, T.W., Kompier, M.A.J., Houtman, I.L.D., Bongers, P.M. (2003). "The *very* best of the Millennium": Longitudinal research and the Demand-Control-(Support) Model. *Journal of Occupational Health Psychology, 8,* 282-305.

Lange, A.H. de, Taris, T.W., Kompier, M.A.J., Houtman, I.L.D., Bongers, P.M. (2005). Different mechanisms to explain reversed effects of mental health on work characteristics. *Scandinavian Journal of Work, Environment and health*, *31*, 3-14.

Lindell, M.K., & Whitney, D.J. (2001). Accounting for Common Method Variance in cross-sectional research designs. *Journal of Applied Psychology, 86*, 114-121.

Leiter, M.P., & Durup, M.J. (1996). Work, home and in-between: A longitudinal study of spillover. *Journal of Applied Behavioral Science, 32*, 29-47.

Marcelissen, F.H.G., Winnubst, J.A.M., Buunk, B., & Wolff, C. J. de (1988). Social support and occupational stress: A causal analysis. *Social Science and Medicine, 26*, 365-373.

Radloff, L.S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385-401.

Rogosa, D. (1980). A critique of cross-lagged correlation. *Psychological Bulletin, 88*, 245-258.

Rothman, K.J., & Greenland, S. (1998). *Modern epidemiology*. Philadelphia: Lippincott-Raven publishers.

Semmer, N., Zapf, D., & Greif, S. (1996). "Shared job strain": A new approach for assessing the validity of job stress measurements. *Journal of Occupational and Organizational Psychology, 69*, 293-310.

Semmer, N.K. (2003). Individual differences, work, stress and health. In. M.J. Schrabracq, J.A.M. Winnubst, & C.L. Cooper (Eds), *The handbook of work & health psychology* (pp. 83-120*)*. John Wiley & Sons Ltd: England.

Schaufeli, W.B., & Van Dierendonck, D. (1993). The construct validity of two burnout measures. *Journal of Organizational Behavior, 14,* 631-647.

Schnall, P.L., Landsbergis, P.A., & Baker, D. (1994). Job strain and cardiovascular disease. *Annual Review of Public Health, 15,* 381-411.

Schumacker, R.E., & Lomax, R.G. (1996). *A beginner's guide to structural equation modeling*. Mahwah, NJ: Lawrence Erlbaum.

Spector, P.E. (1992). A consideration of the validity and meaning of self-report measures of job conditions. *International Review of Industrial and Organizational Psychology, 7,* 123-151.

Spector, P.E., Zapf, D., Chen, P.Y., & Frese, M. (2000). Why negative affectivity should not be controlled in job stress: don't throw out the baby with the bath water. *Journal of Organizational Behavior, 21*, 97-95.

Taris, T.W. (1999). The mutual effects between job resources and mental health: A prospective study among Dutch youth. *Genetic, Social, and General Psychology Monographs, 125*, 433-450.

Taris, T.W. (2000). *A primer in longitudinal data analysis.* Londen: Sage.

Taris, T.W., Bok, I.A., & Caljé, D.G. (1998). On the relation between job characteristics and depression: A longitudinal study. *International Journal of Stress Management, 5,* 157-167.

Taris, T., & Kompier, M. (2003). Challenges of longitudinal designs in occupational health psychology. *Scandinavian Journal of Work, Environment and Health, 29,* 1-4.

Wanous, J.P., Reichers, A.E., & Hudy, M.J. (1997). Overall job satisfaction: How good are single-item measures? *Journal of Applied Psychology, 82*, 247-252.

Williams, L.J., & Podsakoff, P.M. (1989). Longitudinal field methods for studying reciprocal relationships in organizational behavior research: Toward improved causal analysis. *Research in Organizational Behavior, 11,*247-292.

Zapf, D., Dormann, C., & Frese, M. (1996). Longitudinal studies in organizational stress research: A review of the literature with reference to methodological issues. *Journal of Occupational Health Psychology, 1,* 145-16

4

Effects of stable and changing demand-control histories on worker health

Appeared as:

De Lange, A. H., Taris, T. W., Kompier, M. A. J., Houtman, I. L. D., Bongers, P. M. (2002). Effects of stable and changing demand-control histories on worker health. *Scandinavian Journal of Work, Environment and Health, 28*, 94-108.

4.1 Abstract

The present study examined effects of stability and change in exposure to job demands and job control (demand-control histories) in relation to the strain hypothesis of Karasek's demand-control model. The hypotheses [(i) high (low) levels of ill health were expected for workers exposed to stable levels of high (low) job demands and low (high) job control, (ii) decreases (increases) in strain-related health outcomes were expected for workers with positive (negative) changes in job demands and job control, (iii) workers reporting major changes in job demands or control were expected to report more "objective" job changes] were tested with a group-by-time analysis of variance using data from a four-phase Dutch cohort study on musculoskeletal disorders, absenteeism, stress and health. Associations between demand-control histories and job changes were tested in a log-linear analysis.

The hypotheses for the stable exposure groups were supported for depression and job satisfaction. Those for positive and negative changes were partially supported. There was no relation, however, between the level of stability or changes in exposure to demands and control for the registered duration and frequency of sickness absence. Finally, the results showed that workers reporting major changes in demand-control histories over time had more job changes, and those reporting job changes towards high strain jobs evaluated the changes as more distressful. This longitudinal study supports the strain hypothesis of the demand-control model and shows a significant association between major changes in demand-control histories and job changes.

4.2 Introduction

In 1979 Robert Karasek introduced his job demand-control model (DC model; Karasek, 1979). Due to its simplicity and broad applicability, this model has become very influential in occupational health psychology and epidemiology (Schreurs et al., 1999; Theorell, 2000). According to it, psychosocial work environments can be characterized in terms of a combination of job demands and job control (or decision latitude). *Job demands* refer to the psychological stressors in the work environment, such as having to complete much work and working under time pressure. *Job control* consists of two components, namely decision authority (opportunity to make decisions concerning the job) and skill discretion (amount of skill used in the job), which are usually combined into a single measure.

Based on various combinations of demands and control, the demand-control model distinguishes among four types of jobs, namely, high strain jobs, low strain jobs, active jobs and passive jobs. High strain jobs are characterized by high demands and low control. People working in such jobs are expected to have a relatively high risk of developing high blood pressure and ill-health (Karasek et al., 1979; Karasek & Theorell, 1990; Theorell, 2000). In contrast, people working in low strain jobs, which are characterized by low demands and high control, will develop a lower than average number of health complaints across time. Active jobs are characterized by high job demands and high job control. These jobs are expected to result in an average number of health complaints (Karasek & Theorell, 1990). The same number of health complaints is expected for passive jobs, which are characterized by low demands and low control.

The assumption that high strain jobs result in health complaints is known as the *strain hypothesis* of the demand-control model. It is supported by an impressive body of mainly cross-sectional research (de Jonge & Kompier, 1997; Kristensen, 1999; van der Doef & Maes, 1999). However, covariation is not causation, and therefore it is fortunate that, over the last decade, several longitudinal studies examining the demand-control model have been published as well, albeit less consistently and, perhaps, less convincingly than earlier cross-sectional studies (de Lange et al., 2001). One explanation may be that most longitudinal studies on the DC model are based on a single point assessment of workers´ perceptions of their work situation at the moment they filled out the questionnaire (Johnson & Stewart, 1993; Landsbergis & Theorell, 2000; Schnall et al., 1994). In other words,

workers' judgments of their work situation may be affected by external factors and possibly result in less accurate and less reliable assessments of the characteristics of their work. Longitudinal measurement of these characteristics may circumvent this problem by providing a more stable and, therefore, more reliable repeated-measures assessment of worker's work environment. This circumvention, in turn, may lead to more consistent evidence for the causal effects of the work environment on worker health.

A related issue is the effect of *cumulative* exposure to high strain on worker health. Karasek and Theorell (1990) have argued that duration of exposure to an unfavorable work situation is related nonlinearly to health, such that long-term exposure has comparatively stronger detrimental effects than short-term exposure (Frese & Zapf, 1988). Unfortunately, insofar as their research designs have allowed researchers to examine the development of ill-health in response to chronic job strain, they have tended to ignore this issue. Similarly, few researchers have addressed the health effects of *across-time changes* in job demands and control, in spite of the potential offered by such changes to increase our understanding of the effects of the work environment on health: Do changes in the work environment lead to subsequent interpretable across-time change in worker health?

Our study was designed to deal with these issues. Using data from a four-phase panel study among a sample of 824 Dutch workers, we examined and contrasted the effects of exposure to various combinations of job demands and control with respect to worker health. As such, this study aimed to contribute to our understanding of the effects of stability and change in job demands and job control on worker health.

Longitudinal research on the effects of exposure to job demands and control on worker health. There is some evidence that cumulative exposure to (a combination of) high demands and low control or a *change* towards a high strain results in adverse health outcomes. Fenwick and Tausig (1994) have examined the effects of macroeconomic changes (such as recessions) on exposure to stress. They reported that higher unemployment rates increase stress and diminish job satisfaction via reduced decision latitude and increased job demands. Furthermore, Bourbonnais et al. (1999) found that cumulative exposure to high demands and low control across time is associated with higher psychological distress and emotional exhaustion than other types of work. Furda et al. (1994) examined changes in the dimensions of the demand-control-support model and found significant main and interaction effects of adverse changes in demands and social

support on health complaints and recovery complaints across time. They found no effects for control. Janssen and Nijhuis (2001) focused on positive changes in the dimensions of the demand-control-support model. They reported that these positive changes resulted in lower levels of fatigue, emotional exhaustion, and psychological distress across time. De Jonge et al. (1998) examined the lagged effects of changes in these work characteristics on health as well. They found that an increase in work pressure was associated with increases in emotional exhaustion and depersonalisation across time, whereas an increase in control was associated with an increase in job satisfaction. Finally, Theorell et al. (1990) have looked at differences between high strain and work without high strain across time and found that total plasma testosterone levels increased when strain diminished in sedentary work.

The aforementioned studies suggest that (cumulative) exposure to a combination of high demands and low control affects health longitudinally. Yet, none of the studies systematically contrasted the effects of stability and change in across-time exposure to demands and control. An exception to these studies is that of Schnall et al. (1998). These authors used an interesting way of analysing stability and change in exposure by creating four "exposure profiles" (compare with Johnson & Stewart, 1993), including two stable exposure profiles (ie, workers who were in the "high strain" condition in both phases of their study and workers who were in the "no-high strain" condition at both occasions) and two changing exposure profiles (ie, workers who changed from the "high strain" condition to the "no-high strain" condition, and vice versa). In line with the strain hypothesis of the DC model, those who were in the high strain condition on both occasions reported the highest levels of ambulatory blood pressure. Furthermore, negative and positive change in exposure to demands and control across time partially predicted negative and positive changes, respectively, in ambulatory blood pressure.

One important strength of the study of Schnall et al. (1998) was that it explicitly revealed the effects of *cumulative* exposure to high strain on worker health, in comparison with cumulative exposure to no-high strain and two variations of noncumulative exposure to high strain. As such, their study demonstrated the detrimental effects of high job strain on worker health more clearly than any previous study had. However, this study (Schnall et al., 1998) left several important questions unanswered as well. One issue concerns the fact that Schnall et al. (1998) distinguished between the "high strain" versus "no-high strain"

conditions only. Although this practice is consistent with Karasek's (1979) juxtaposition of these two job types, it disregards that the demand-control model includes passive and active job types as well. An interesting question, therefore, is whether more-detailed distinctions should be made within the cluster of no-high strain jobs: e.g., does a change from the passive quadrant to the high strain quadrant of Karasek's model (1979) have the same effect on worker health as a change from the low strain to the high strain quadrant?

Another issue is that it would seem important to examine whether subjectively experienced changes in the work environment, as studied by Schnall et al. (1998) have a basis in reality. Essentially, Karasek's (1979) demand-control model is an *environmental* model, in that it pretends to explain how the characteristics of the "objective" work environment affect worker well-being. Consequently, a second question is whether changes in the work environment can be linked to changes in subjectively experienced work conditions and health outcomes. A positive answer to this question would strengthen the case for the reasoning that worker health is affected causally by characteristics of the work environment.

Finally, ambulatory blood pressure was the single outcome variable included in the Schnall et al. (1998) study. Obviously, this is just a single instance of a wider and more varied set of possible health outcomes, including subjective and "objective" health outcomes such as registered sickness absence and depression. It is therefore important to examine whether the findings of Schnall et al. (1998) generalize to a wider set of outcome variables.

Research questions and hypotheses

In line with this reasoning, this paper addresses the following three core questions:

i) Are Karasek's predictions for the differences in strain between the four different job types (high strain, low strain, active and passive work) supported for groups with stable exposure to demands and control?

ii) Do positive (negative) changes in exposure to demands and control result in decreased (increased) strain levels across time, in agreement with the predictions of the demand-control model?

iii) Can change in reported exposure to demands and control be linked to "objective" change in the work environment?

With respect to the first question, in line with the demand-control model, we expect cumulative high strain to result in diminished health across time because this type of job can be seen as a chronic stressor due to the low amount of control to "buffer" the effects of high job demands. Therefore, employees working in this type of job for a prolonged period will develop (symptoms of) diminished health, which reflects an unproductive and unhealthy response to the high demands (Karasek & Theorell, 1990; Le Blanc et al., 2000; Selye, 1976). The lowest levels of strain are expected for the cumulative low strain group. The other two Karasek job types (active versus passive work) are expected to take an intermediary position between the low and high strain groups in terms of levels of strain or health complaints. These expectations can be expressed in the following hypotheses:

(i) Employees with high demands and low control (high strain jobs) on all occasions will report the *highest level* of strain when compared with the other three stable groups across time (hypothesis 1a),

(ii) These employees will also report a significant *increase* in strain across time (hypothesis 1b).

(iii) Employees with low demands and high control (low strain jobs) on all occasions will report the *lowest* level of strain when compared with the other three stable groups across time (hypothesis 2a).

(iv) These employees will also report a stable level of strain across time (hypothesis 2b).

(v) Employees with high demands and high control (active work) on all occasions will report an *average* level of strain when compared with the other three stable groups across time (hypothesis 3a).

(vi) These employees will also report a stable level of strain across time (hypothesis 3b).

(vii) Employees with low demands and low control (passive work) on all four occasions will report an *average* level of strain when compared with the other three stable groups across time (hypothesis 4a).

(viii) These employees will also report a stable level of strain across time (hypothesis 4b).

With respect to the second question, do positive (negative) changes in exposure to demands and control result in decreased (increased) strain levels across time, consistent

with the predictions of the demand-control model, employees may change regarding their exposure to demands and control across time. In terms of Karasek's DC model, such changes can be for better or for worse (Karasek, 1979). *Positive changes* include changes from a high strain job to a low strain job or an active/passive job, and changes from an active/passive job to a low strain job. These changes are deemed positive because, according to the DC model, they should result in lower levels of health complaints. On the other hand, *negative changes* include changes from a low strain /active/passive job to a high strain job, and changes from a low strain job to an active/passive job. These changes should result in a higher number of health complaints. In accordance with this reasoning, the following hypotheses were developed:

(i) Positive changes from a high strain job to any no-high strain job (i.e., low strain, active or passive work) will result in a significant *decrease* in strain across time (hypothesis 5).

(ii) Negative changes from any no-high strain job to a high strain job will result in a significant *increase* in strain across time (hypothesis 6).

(iii) Positive changes from active/passive work to a low strain job will result in a significant *decrease* in strain across time (hypothesis 7).

(iv) Negative changes from a low strain job to active/passive work will result in a significant *increase* in strain across time (hypothesis 8).

For the third question, can change in reported exposure to demands and control be linked to “objective” change in the work environment, the studies that have examined the longitudinal effects of changes in exposure to demands and control have generally failed to explore the causes underlying change in self-reported exposure to demands and control (Bourbonnais et al., 1999; Furda et al., 1994; de Jonge et al., 1998; Theorell & Karasek, 1990; Schnall et al., 1998; but see Fenwick & Tausig, 1994). The explanatory and dependent variables in these studies may therefore be confounded due to common method variance and related methodological artefacts, rendering it virtually impossible to draw causal inferences (Kasl, 1998). Therefore, it is important to examine the link between subjective and “objective” change in work characteristics more closely.

If Karasek's (1979) Demand-Control model is indeed primarily an environmental model, one would expect that subjective changes in work characteristics would be accompanied by “objective” changes in the work environment (more specifically, by actual turnover).

Conversely, the degree of turnover should be considerably lower if no such change in subjective work characteristics is observed. Thus, we expect that groups reporting major changes in exposure to job demands and job control over time (i.e., changes from a low strain job to a high strain job or vice versa) report more job changes than other groups (hypothesis 9).

4.3 Method

Sample

The current study was conducted within the framework of the prospective Dutch cohort Study on Musculoskeletal disorders, Absenteeism, Stress and Health (SMASH, de Jonge et al., 2000; Ariëns et al., 2001; Hoogendoorn et al., 2000). On baseline (i.e., 1994), 1789 employees working in 34 different companies, located throughout the Netherlands, participated in this study. Each year (up to 1997) the respondents received a self-administered questionnaire, tapping concepts such as general working conditions, changes in the workplace, psychosocial work characteristics, work satisfaction, physical load at work, psychosocial and physical health, and background factors. Furthermore, information concerning registered sickness absence was annually obtained (the design of the SMASH study is described in more detail in Ariëns et al., 2001; Hoogendoorn et al., 2000).

In order to be included, companies were required not to be involved in major reorganizations during the three years of examination and that the pre-study annual turnover rate of their workforce was lower than 15%. Further, only respondents were selected who had been working for at least one year in their current job, for at least 20 hours per week. Blue-collar jobs as well as white-collar jobs were included.

The data in this study are based on the annual questionnaires measuring psychosocial variables and the company-registered sickness absence data on four occasions (1994-1995-1996-1997). To ensure valid and reliable results, employees who had a temporary contract and employees receiving a benefit because of (partial) disability were excluded, meaning that 47 of the 1789 respondents were excluded. The response rates were relatively high and varied between 84% (N = 1742) at baseline to 85% (N = 1473) at the third follow-up measurement. Analysis of the attrition revealed that dropouts tended to report more strain and less control across time, a quite common phenomenon (Taris, 2000). After listwise

deletion of missing values, the sample included 1477 employees (70% male; average age at baseline was 35.6 years, *SD* = 8.8; average number of years of employment was 9.6 years, *SD* = 7.7).

Measures

Job demands. Job demands were measured using a five-item Dutch version of Karasek´s (27) Job Content Questionnaire (cf. de Jonge et al., 2000; e.g., ” My job requires working very fast”, 1 = strongly disagree", 4 = "strongly agree"). The reliability (Cronbach’s alpha) of this scale varied from .65 to .72 across occasions (median alpha = .71).

Job control. Consistent with Karasek's (1985) conceptualisation, job control was measured as the mean of two scales. *Skill discretion* was measured using a five-item scale (e.g., ”my job requires that I learn new things"), and *Decision authority* was measured using a three-item scale (e.g., “My job allows me to take many decisions on my own”, 1 = "strongly disagree", 4 = "strongly agree"). The reliabilities of this scale ranged from .81 to .83 (median alpha = .82).

Strain outcomes. The current study included four strain outcomes. 1) *Depression* was measured with an 11-item Dutch version of the CES-D scale (Center for Epidemiological Studies Depression; Radloff, 1977; Kohout et al., 1993). This scale taps symptoms of depressive mood (e.g., "The past two weeks I felt lonely", 1 = "hardly ever or never", 3 = "much or most of the time"). The reliability varied from .74 to .84 (median alpha = .77). 2) *Job satisfaction* was measured by a single item ("Do you mostly enjoy your work?", 1 = "strongly disagree", 4 = "strongly agree"). Obviously, the reliability of a single-item scale cannot be computed. However, a recent meta-analysis demonstrated that single-item measures of job satisfaction are usually highly correlated with multi-item scales (Wanous et al., 1997). 3) *Company-registered sickness absence duration* was measured as the period of days of sickness absence that were registered in the past year. Annually, the companies registered the date of the onset and the end of each period of sickness absence. From this registration information was also derived on the frequency of sickness absence. 4) *company-registered sickness absence frequency* refers to the number of sickness spells that started and ended in the past year. The distributions of the sickness absence variables were

positively skewed. Consequently, these were square-root transformed to obtain more normally distributed variables.

Covariates. Age, level of education, gender and years of work experience were used as covariates in the analysis, because these variables are often related to the outcome variables employed in this study. Therefore, failing to control for these variables may result in distortion of the effects of other variables (Karasek & Theorell, 1990; de Jonge et al., 2000; Schnall et al., 1994).

Job change. On all four occasions of the study it was assessed whether the employees had changed jobs over the 12 months preceding, and whether this change had given them distress (categories were "no job change", "job change, not distressing", "job change, rather distressing", "job change, very distressing"). The last two categories were collapsed, yielding a three-category variable ("no job change", "job change, not distressing", and "job change, distressing"). Then the three occasions were combined into a single variable, reflecting whether the employees had experienced at least one job change during the three-year interval between the first and last wave of the study, and, if so, whether this change was distressing. Of the employees 74.0% had not experienced a job change; 20.8% had experienced a no distressing job change (neutral/positive); 5.2% reported at least one distressing job change (negative).

Correlational analysis. Table 4.1 presents the means, standard deviations, and correlations between the different measures at baseline. The correlations between the dependent and independent measures were in the expected direction, with the exception of job demands that was not significantly correlated with sickness absence (neither with absence duration nor absence frequency). As regards the across-time stability of these variables, the Time 1-Time 2 test-retest correlations ranged from .42 (Sickness absence -- Duration) to .65 (for Control: median correlation was .51, all p's < .001); the Time 1-Time 4 test-retest correlations ranged from .27 (Sickness absence -- Duration) to .42 (Job control; median correlation was .45; all p's < .001). Although these correlations are substantial, it is also clear that there is quite some across-time variation in the concepts included in this study. E.g., a Time 1-Time 2 correlation of .65 for Control implies that both measures share roughly only (.65 x .65 x 100 equals) 42% of their variance.

Table 4.1

Means, standard deviations, and correlations among all variables as measured on baseline (listwise deletion of missing data, N=1477)

Variables		*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1.	Gender[a]	.70	.50	1.00									
2.	Age	35.57	8.76	-.15	1.00								
3.	Education[b]	2.65	1.10	.13	-.07	1.00							
4.	Years of experience	9.56	7.72	-.20	.59	-.18	1.00						
5.	Demands	2.60	.45	.04	.02	.03	.02	1.00					
6.	Control	2.82	.49	-.19	.11	.22	.11	-.05	1.00				
7.	Depression	1.27	.27	.11	-.01	-.02	-.03	.13	-.16	1.00			
8.	Job satisfaction	3.35	.72	.11	.04	-.04	.03	-.09	.28	-.19	1.00		
9.	Sickness absence (duration)	22.98	42.10	.11	-.02	-.16	.06	.04	-.11	.17	-.02	1.00	
10.	Sickness absence (frequency)	1.72	1.73	.14	-.15	.01	-.11	.05	-.11	.16	-.09	.70	1.00

Note. [a] 0 = female and 1 = male.

[b] 1= primary education or lower; 2 = lower vocational education; 3 = secondary education or middle vocational education; 4 = higher vocational education; 5 = college/university education.

correlations of .05 and over are significant at $p < .05$, correlations of .09 and over are significant at $p < 001$.

After correction for measurement error by dividing the observed correlation of .65 by the reliability of the measures (i.e., the median alpha for this concept of .82), this figure increases to (.79 x .79 x 100 equals) 62% shared variance. Thus, even in the most optimistic case (high Time 1-Time 2 correlations and correction for attenuation) about 40% of the variance in Time 2 remains unaccounted for. This suggests that in examining the longitudinal effects of job demands and job control on worker health, it may be necessary to include information concerning *change* on these aspects into the analysis. Below we discuss one way of accomplishing this.

Data analysis: Creation of Demand-Control-histories. Eleven groups were created on the basis of their exposure to different combinations of job demands and control. First, all variables measuring job demands and job control at each of the four waves included in this study were dichotomised using a median split procedure. Within each measurement and consistent with the ideas of Karasek (1979), four job demands/job control combinations were formed. As this study included four waves, theoretically 4 (4 demands/control combinations) to the fourth power (4 waves) equals 256 different DC-histories (DCH's) could be distinguished. Four of these consisted of stable DCH's, i.e., in which no transition from one quadrant to another was observed during the four occasions (*N*'s varying from 61 for the stable high strain group to 108 for the stable low strain group, cf. Table 4.2).

Group 5-10 consisted of employees whose DCH's included *one* transition across time. The timing of that transition was deemed irrelevant. Group 5 included DCH's in which the employees were initially in the low strain quadrant and at a later point in time moved to the high strain quadrant ($N = 8$). A low incidence of this pattern was expected, as this transition presents a major change in (the perception of) one's job characteristics. Similarly, group 6 consisted of employees who moved from the high strain to the low strain quadrant ($N = 12$; another major change, coinciding with a low frequency of occurrence). Group 7 included employees who changed from the active/passive quadrants to the low strain quadrant ($N = 71$); group 8 included employees who changed from the low strain quadrant to the active/passive quadrants ($N = 171$). Group 9 consisted of employees who moved from active/passive work to the high strain quadrant ($N = 76$). Group 10 included those who moved from the high strain quadrant to the active/passive quadrants ($N = 123$).

The eleventh group consisted of the 653 subjects (44%) whose DCH's included more than a single transition. These relatively complex and ambiguous histories could not be

classified theoretically and were omitted from the analysis. Consequently, this manuscript presents the results of a total of 824 respondents.

Table 4.2

Description of DC-histories

Group number	Group label	*N*
1.	Stable high strain group (no across-time change)	61
2.	Stable low strain group (no across-time change)	108
3.	Stable active group (no across-time change)	97
4.	Stable passive group (no across-time change)	93
5.	Change from low strain job to high strain job	8
6.	Change from high strain job to low strain job	12
7.	Change from active/passive job to low strain job	71
8.	Change from low strain job to active/passive job	171
9.	Change from active/passive job to high strain	76
10.	Change from high strain job to active/passive job	123
	Total	824
11.	Other (ambiguous DCH's with > 1 change in job characteristics; omitted from analysis)	653
	Total	1477

Statistical method of analysis. To answer question 1 and 2 the data were analysed using a 10 (Group; the 4 stable and 6 changing DCH's) x 4 (Time: 4 occasions) ANOVA with Time as a within-participants factor and Group as a between-participants factor. For simplicity the employees' scores of depression, job satisfaction, sickness absence duration and sickness absence frequency were analysed separately.

Table 4.3

Means and standard errors of the outcome variables as a function of Time and Group (standard errors in brackets).

	Time				Groups										MANOVA *F*-values		
Variables	Time 1	Time 2	Time 3	Time 4	DCH 1:	DCH 2:	DCH 3:	DCH 4:	DCH 5:	DCH 6:	DCH 7:	DCH 8:	DCH 9:	DCH 10:	Time	Group	Time x Group
Depression	1.27 (.01)	1.34 (.02)	1.36 (.02)	1.38 (.02)	1.42 (.03)	1.19 (.02)	1.33 (.03)	1.31 (.02)	1.57 (.08)	1.34 (.07)	1.24 (.03)	1.25 (.02)	1.34 (.03)	1.39 (.03)	F *(3, 601)* = *12.31***	*F* (9, 603) = 7.89**	*F* (27, 1809) = 1.65*
Job satisfaction	3.34 (.04)	3.32 (.04)	3.23 (.05)	3.25 (.05)	2.79 (.07)	3.61 (.06)	3.46 (.08)	3.16 (.06)	3.20 (.24)	3.41 (.16)	3.56 (.07)	3.49 (.06)	3.08 (.07)	3.09 (.09)	*F* (3, 489) = 2.68*	*F* (9, 491) = 13.99**	*F* (27, 1473) = 1.79**
Sickness absence duration	18.62 (2.08)	23.32 (2.65)	24.79 (3.14)	30.66 (3.79)	36.67 (4.31)	18.50 (3.28)	17.46 (4.40)	24.16 (3.36)	30.70 (13.77)	11.83 (9.74)	19.77 (4.15)	19.01 (2.82)	27.58 (4.08)	37.78 (3.51)	*F* (3, 583) = 3.05*	*F* (9, 585) = 5.53**	*F* (27, 1755) = .88, *ns*
Sickness absence frequency	1.80 (.10)	1.97 (.10)	1.77 (.11)	1.69 (.11)	2.12 (.18)	1.39 (.14)	1.37 (.19)	1.53 (.15)	2.79 (.57)	1.44 (.40)	1.67 (.18)	1.77 (.12)	1.97 (.18)	2.01 (.15)	*F* (3, 583) = 2.21, *ns*	*F* (9, 585) = 3.41**	*F* (27, 1755) = 1.18, *ns*

Note. F-values for sickness absence duration and frequency are based on square-root transformed means.* = p < .05, ** = *p* < .01; DCH 1= stable high strain group; DCH 2= stable low strain group, DCH 3= stable active group; DCH 4= stable passive group; DCH 5= change low strain to high strain; DCH 6= change high strain to low strain; DCH 7= change active/passive to low strain; DCH 8= change low strain to active/passive; DCH 9= change active/passive to high strain; DCH 10= change high strain to active/passive.

To obtain more insight in the nature of the association between the frequency and valence of job change and different DC-histories (question C), two log-linear analyses were conducted (Fienberg, 1980; Knoke et al., 1980). As in ordinary cross-table analysis, log-linear analysis examines the strength of associations between two (or more) qualitative variables. However, log-linear analysis fosters understanding of possible associations between variables by providing statistical tests, showing *which* elements of a two-way cross table are responsible for this association. To this aim, log-linear analysis distinguishes between main effects and interaction effects. A main effect may be interpreted as indicating the difference between the expected cell frequency for this variable and the observed cell frequency. Log-linear analysis provides a statistical test for *each category* of this variable, showing whether the number of observations in this category deviates significantly from what would be expected for this category. An interaction effect between two variables may be understood in a similar fashion: for all cells of a two-way crosstabulation, it presents the deviation between what would be expected for this cell and the actual number of observations in that cell, *net* of the main effects of the two constituent variables. Log-linear effect parameters are actually computed in a rather sophisticated manner (Fienberg, 1980), but this basic introduction suffices to understand the results of our analyses.

4.4 Results

Comparison of means in the preliminary analysis. Table 4.3 presents the means and standard deviations of the outcome variables as a function of Time and Group. As this table reveals, there were significant main effects of Time for Depression, F (3, 601) = 12.31, $p <$ .01; for Job satisfaction, F (3, 489)= 2.68, $p < .05$; and for Sickness absence duration, F (3, 583)= 3.05, $p < .05$. The findings are highly similar across these three variables: the scores tend to become more unfavourable across time (i.e., more depression and longer average sickness absence duration, lower job satisfaction). For Sickness absence frequency no main effect of Time was observed, $F(3, 583)=2.21$, *ns.*

Main effects of Group were found for Depression, $F(9, 603) = 7.89$, $p < .01$; Job satisfaction, F (9, 491) = 13.99, $p <.01$; Sickness absence duration, $F(9, 585) = 5.53$, $p <$ .01. and Sickness absence frequency, $F(9, 585) = 3.41$, $p < .01$. The pattern of effects is rather similar across groups, with groups 1 (stable high strain), 5 (low strain to high strain),

and 10 (high strain to active/passive job) reporting the most negative outcomes in terms of depression, job satisfaction, sickness absence duration and frequency, and groups 2 (stable low strain), 7 (active/passive to low strain), and 8 (low strain to active/passive job) reporting relatively the most favourable health outcomes.

Significant interaction effects between Time and Group were found for Depression, $F(27, 1809) = 1.65$, $p < .05$, and Job satisfaction, $F(27, 1473) = 1.79$, $p < .01$ (means for these interaction effects not shown in Table 3). For the two "objective" health indicators (Sickness absence duration and Sickness absence frequency) no significant interaction effects were found. The interaction effects for depression and job satisfaction are elaborated below, in conjunction with a discussion of the hypotheses for this study.

Differences among stable exposure groups (Question 1, Hypotheses 1-4). Figure 4.1 presents the relevant means for the stable exposure groups for depression and job satisfaction. For Depression, a Group (DCH 1-4) by Time (4 occasions) ANOVA with planned contrasts on Time revealed main effects of Time, $F(3, 308) = 6.14$, $p < .05$, and Group, $F(3, 310) = 15.12$, $p < .01$. These main effects were further qualified by a Group by Time interaction effect, $F(9, 930) = 1.08$, $p < .01$. For Job satisfaction similar results were obtained: main effects of Time, $F(3, 252) = 3.32$, $p < .05$, and Group, $F(3, 254) = 29.12$, $p < .01$, and a Group by Time interaction effect, $F(9, 762) = 2.39$, $p < .05$. Tukey's Least Significant Difference test (LSD) revealed that, compared to the other stable groups, respondents in the stable high strain group reported the highest level of depression and lowest level of job satisfaction across time (Hypothesis 1a supported). Furthermore, the respondents in the low strain group reported the lowest levels of depression and the highest levels of job satisfaction, except compared to the stable active group when measuring job satisfaction (Hypothesis 2a partially supported). The active/passive workers present more or less average results (Hypotheses 3a and 4a supported).

As expected, for the high strain group levels of Depression (Job satisfaction) increased (decreased) significantly, respectively $F(3, 57) = 2.92$, $p < .05$, and $F(3, 48) = 5.16$, $p < .01$ (Hypothesis 1b supported). For the three other stable groups no across-time change was observed (Hypotheses 2b, 3b, 4b supported).

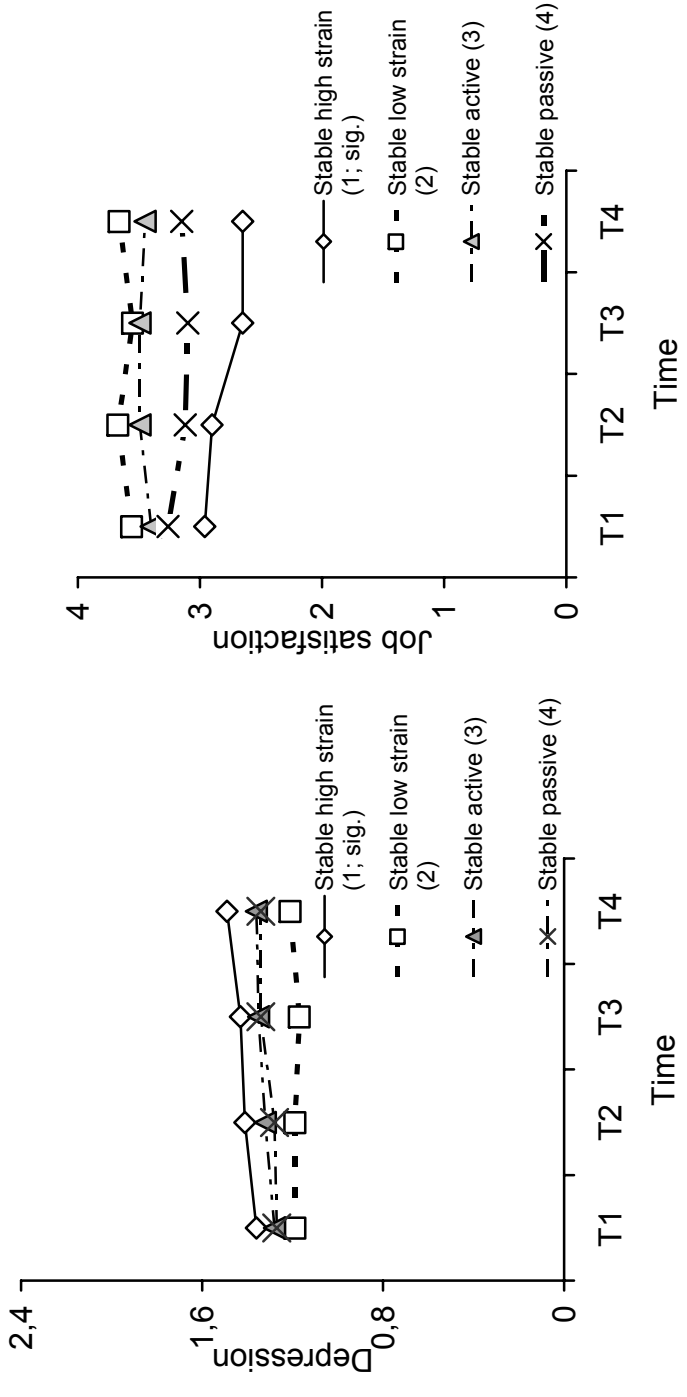


Figure 4.1
Changes in depression (left) and job satisfaction (right) for the four stable exposure groups (stable DCH's); Note. sig.: significant time-effect ($p<.05$)

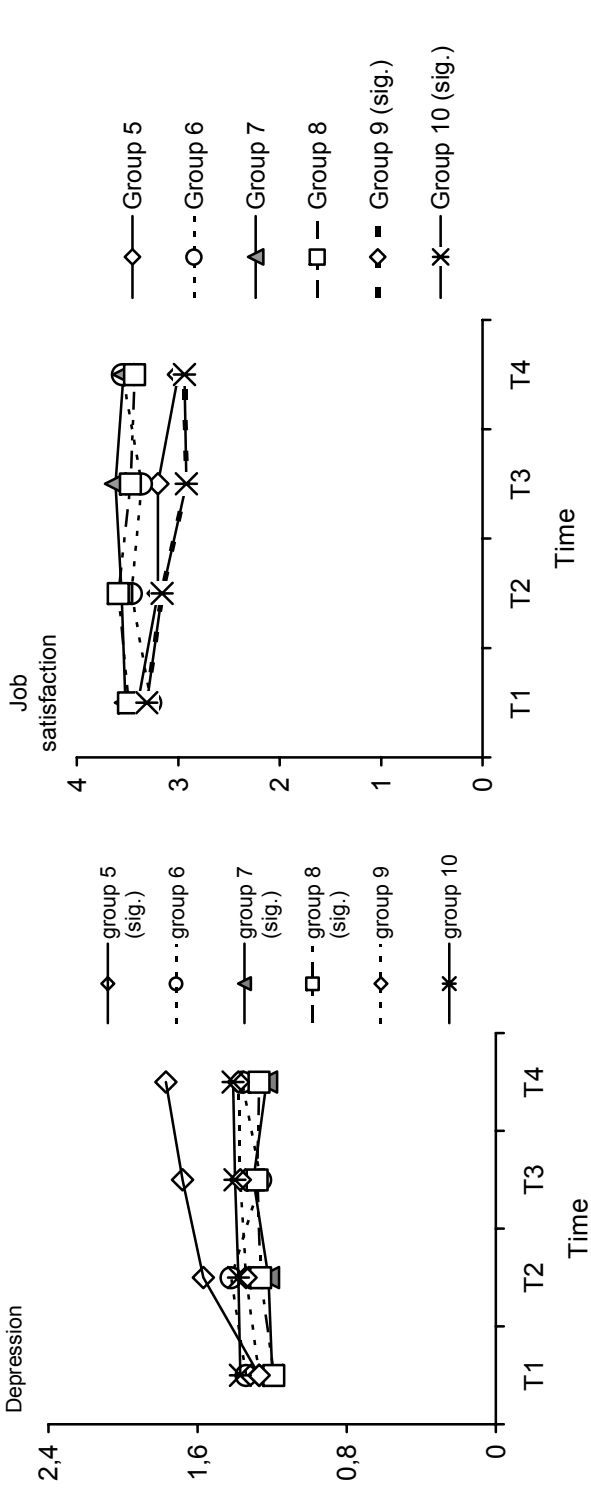


Figure 4.2

Changes in depression (left) and job satisfaction (right) for the six changing exposure groups (changing DCH's)

Note. sig.= significant time-effect ($p<.05$), group 5= change from low strain to high strain, group 6= change from high strain to low strain, group 7= change from active/passive to low strain, group 8= change from low strain to active/passive, group 9= change from active/passive to high strain, group 10= change from high strain to active/passive.

Changing exposure groups (Question 2, Hypotheses 5-8). Figure 4.2 presents the relevant means for the changing exposure groups for depression and job satisfaction. For Depression, a Group (DCH 5-10) by Time (4 occasions) ANOVA with planned contrasts on Time revealed main effects of Time, F (3, 291) = 8.51, $p < .01$, and Group, F (5, 293) = 5.39, $p < .01$. Furthermore, there was a Group by Time interaction effect, F(15, 879) = 1.99, $p < .05$. For Job satisfaction a main effect of Group, F (5, 237) = 7.51, $p < .01$, was obtained, as well as a Group by Time interaction effect, F (15, 711) = 1.71, $p < .05$.

Analyses for the exposure groups separately revealed the following for the hypotheses for the changing exposure groups. First, only partial support was found for Hypothesis 5. The change from high strain to active/passive work (group 10) was only significant for the dependent variable job satisfaction, F (3, 35) = 3.22, $p < .05$. No significant results were found for Depression nor for the change from high strain to low strain (group 6). Second, the results for the changing exposure groups also provide only partial support for Hypothesis 6. Only the change from low strain to high strain (group 5) was associated with a significant increase in depression, F (3, 5) = 9.32, $p < .05$, but not with a significant decrease in job satisfaction across time. The change from active/passive work to high strain (group 9) was associated with a significant increase in job satisfaction, F (3, 48) = 6.46, $p < .01$, but not with a significant decrease in depression across time. Finally, Hypotheses 7 and 8 were supported for depression only. The change from active/passive work to low strain (group 7) was associated with a significant decrease in depression across time, F (3, 57) = 3.77, $p < .05$. Whereas, the change from low strain to active/passive work (group 8) was associated with a significant increase in depression, F (3, 100) = 5.38, $p < .01$. These changing exposure groups showed no significant changes in job satisfaction.

Possible link between subjective and "objective" job changes (Question 3, Hypothesis 9)? Table 4.4 presents the frequency of job change as a function of DCH and type of change[5]. A distinction was made among three categories: "no job change" versus "job change, not distressing" versus "job change, distressing". This table reveals that the number and type of job changes differs strongly across groups, as evidenced by a significant association between DCH and Type of change, chi-square (8, N = 824) = 41.04, $p < .01$.

[5] When we controlled for these changes in our analyses for depression, job satisfaction and sickness absence measures no different results were found for the above presented group effects.

Table 4.4

Frequency of job change as a function of Demand-Control-history and Type of change

Demand-Control-history		No job change	Job change		Total
			Neutral/positive	Negative	
1	Stable high strain	47 (77.0%)	7 (11.5%)	7 (11.5%)	61 (7.4%)
2	Stable low strain	75 (69.4%)	29 (26.9%)	4 (3.7%)	108 (13.1%)
3	Stable active	80 (82.5%)	15 (15.5%)	3 (3.1%)	97 (11.8%)
4	Stable passive	74 (79.6%)	17 (18.3%)	2 (2.2%)	93 (11.3%)
5	Low strain to high strain	2 (25.0%)	4 (50.0%)	2 (25.0%)	8 (1.0%)
6	High strain to low strain	5 (41.7%)	5 (41.7%)	2 (16.7%)	12 (1.5%)
7	Active/passive to low strain	45 (63.4%)	21 (29.6%)	5 (7.0%)	71 (8.6%)
8	Low strain to active/passive work	134 (78.4%)	33 (19.3%)	7 (4.1%)	171 (20.8%)
9	Active/passive work to high strain	55 (72.4%)	15 (19.7%)	6 (7.9%)	76 (9.2%)
10	High strain to active/passive work	93 (75.6%)	25 (20.3%)	5 (4.1%)	123 (14.9%)
Total		610 (74.0%)	171 (20.8%)	43 (5.2%)	824 (100.0%)

Chi-square (18, $N = 824$) = 41.1, $p < .01$

Type of demand-control history and job change. Two log-linear analyses were conducted. In the first, the association between DCH and Job change (no change vs. change) was examined. For simplicity and to obtain reasonably large cell frequencies we collapsed across DCH's, yielding a trichotomous qualitative variable. The four stable

DCH's were included in the first category. Relatively few job changes were expected for these DCH's, as there was no change in job characteristics. The second category comprised the two DCH's in which a major change in job characteristics had occurred (i.e., a change from low strain to high strain or from high strain to low strain, DCH 5 and 6, respectively). As the characteristics of the work environment seemed to have changed strongly for these two DCH's, we expected a relatively high number of job changes for this category. The remaining DCH's (DCH's 7-10) were assigned to the third category. This category was expected to take an intermediary position between the two other categories in terms of frequency of job change.

Table 4.5, Panel A, presents the relevant cell frequencies as well as the results of the first log-linear analysis. As this table shows, 74.0% of the employees did not report a job change, while the remaining 26.0% did; the corresponding log-linear effect parameters are .27 (there are more employees in the "no job change"-category than expected) and -.27 (there were fewer employees than expected in this category), p's < .001, respectively. Similarly, the employees were not evenly distributed across Type of DCH. There were more employees than expected in the stable DHC category (DCH's 1-4) and minor DCH change category (positive log-linear parameters for these two categories, cf. Table 4.5), whereas relatively few employees were in the major DCH change category (only 2.4%, a negative effect parameter of -1.93, $p < .001$).

According to Hypothesis 9, DCH's involving a major change in work characteristics will report more job changes than other DCH's. As expected, there was a statistically significant association between Type of DCH and Job change, chi-square (2 *df*, $N = 824$) = 17.2, $p < .001$. As expected, closer inspection of Table 4.5 reveals that this interaction is due to the fact that the Major DCH change group reports relatively many job changes (65.0% reports at least 1 job change), whereas the other two DCH categories are more or less similar (about a quarter of the respondents in these categories reports a job change; Hypothesis 9 supported). Indeed, follow-up analysis revealed that the association between Type of DCH and Job change disappears when the major DCH change category is omitted from the analysis, chi-square ($df = 1$, $N = 804$) = .97, *ns*, showing that the stable DCH group and the minor DCH change group do not differ significantly in terms of their levels of (self-reported) turnover.

Table 4.5

Associations between Type of Demand-Control-history and Job Change (all observations, panel A) and Valence of Demand-Control-history and Valence of type of change (job changes only, panel B). First row: cell frequencies and percentages (between brackets); second row: log-linear effect parameters (additive model), DCH numbers correspond with those presented in Table 4.2

Panel A:

Association between Type of DC-history and Job change

	Job change		
DC-history	No change	change	total
Stable DCH groups	276 (76.7%)	84 (23.3%)	360 (43.7%)
(DCH 1-4)	.33***	-.33***	.84***
Major DCH change	7 (35.0%)	13 (65.0%)	20 (2.4%)
(DCH 5-6)	-.58***	.58***	-1.93***
Minor DCH change	327 (73.6%)	117 (26.4%)	444 (53.9%)
(DCH 7-10)	.25**	-.25**	1.09***
Total	610 (74.0%)	214 (26.0%)	824 (100.0%)
	.27**	-.27**	

chi-square (2, N = 824) = 17.2***

Panel B:

Association between Valence of DC-history and Valence of change

	Valence of change		
Valence of DC-history	neutral/positive	negative	total
Neutral DCH groups	115 (84.6%)	21 (15.4%)	136 (63.5%)
(DCH 2-4, 7-8)	.23*	-.23*	.71***
Negative DCH groups	26 (63.4%)	15 (36.6%)	41 (19.2%)
(DCH 1, 5, 9)	-.34*	.34*	-.20
Positive DCH groups	30 (81.0%)	7 (19.0%)	37 (17.3%)
(DCH 6, 10)	.11	-.11	-.51***
Total	171 (79.9%)	43 (20.1%)	214 (100.0%)
	.62***	-.62***	

chi-square (2, $\underline{N}$ = 214) = 8.8*

Note. * = $p < .05$, ** = $p < .01$, *** = $p < .00$

Valence of job change and demand-control history. Additionally, Table 4.5, Panel B, presents the results of a second exploratory log-linear analysis, dealing with the association between the Valence of a job change and the Valence of DC-histories. As noted earlier on, the employees not only reported whether they had changed jobs, but they also indicated whether they found this change distressing (Valence: not distressing job change vs. distressing job change). Further, based on the ideas of Karasek (1), DCH's that included a job change towards the high strain category (DCH 5 and 9) and the stable high strain DCH (DCH 1) were denoted as "negative"; DCH's that included a job change out of the high strain category were considered "positive" (DCH's 6 and 10); the remaining DCH's were denoted as "neutral" DCH's. Note that this analysis includes only the employees who reported at least 1 job change. Also note that this analysis is statistically independent from the previous log-linear analysis: knowing that one has changed jobs is not in any way informative concerning the direction of this change.

Again, the employees were not evenly distributed across the categories of Valence of job change and Valence of DCH. More importantly, there was a significant association between these two variables, chi-square ($df = 2$, $N = 214$) = 8.8, $p < .05$. Closer inspection of the interaction reveals that about one-third of the employees in the Negative DCH category (36.6%) experienced their job change as negative (or distressing), compared to 15.4% in the neutral DCH category and 19.0% in the positive DCH category. Again, omitting the negative DCH group from the analysis resulted in an insignificant association between Valence of job change and Valence of DCH category, chi-square ($df = 1$, $N = 173$) = .26, *ns*, revealing that the negative DCH category deviated strongly from the two other categories.

In summary, these results indicate: 1) that workers reporting major changes in DC-histories across time also experience more “objective” job changes compared to workers who report less dramatic changes in their DC-histories, 2) that job changes towards high strain jobs are also evaluated by workers as more distressful (Hypothesis 9 supported).

4.5 Discussion

The present study examined the effects of exposure to various combinations of job demands and job control in the context of a four-wave panel study among 824 Dutch workers. Consistent with the notions first outlined by Karasek (1979), at each wave we distinguished between high strain jobs, low strain jobs, active jobs, and passive jobs. Building on previous work by Schnall et al. (1998), a classification of 10 theoretically distinct across-time Demand-Control-histories (or "exposure profiles", Johnson & Stewart, 1993) was developed. For each of these DCH's explicit hypotheses were formulated concerning their across-time development in terms of “subjective” and “objective” health outcomes. By contrasting the scores obtained for these DCH's, we aimed to promote our understanding of the across time health effects of exposure to various combinations of job demands and job control. For convenience, Table 4.6 presents a summary of the hypotheses tested in this study.

Are Karasek’s predictions for the strain differences among the four different job types supported for groups with stable exposure to demands and control? As expected, the highest levels of strain were reported in the stable high strain jobs, whereas in the stable low strain jobs relatively little strain was reported. Further, the employees in the stable high strain DCH reported increasing strain across time, while there were no such time effects for the other three stable DCH's. Thus, the adverse effects of high strain tend to become more pronounced across time. Note, however, that these positive findings apply to depression and job satisfaction only; for the two sickness absence measures (sickness absence frequency/duration) the hypotheses were largely rejected (see below for a discussion).

Do positive (negative) changes in exposure to demands and control result in decreased (increased) strain levels across time? Generally, we expected that positive (negative) changes in terms of job demands and job control would be associated with correspondingly lower (higher) levels of strain. Table 4.6 shows that this basic hypothesis received moderate support at best.

Table 4.6

Summary of support for the hypotheses

		Outcome variables			
Hypotheses involving health outcomes		Depression	Job (dis-) satisfaction	Sickness absence (duration)	Sickness absence (frequency)
1a	stable high strain job reports highest level of strain	+	+	+	+
2a	stable low strain job reports lowest level of strain	+	+/-	-	-
3a	stable active job reports average level of strain	+	+	-	-
4a	stable passive job reports average level of strain	+	+	+	+
1b	stable high strain job reports significant increase in strain across time	+	+	-	-
2b	stable low strain job reports no significant increase across time	+	+	-	-
3b	stable active job reports no significant increase across time	+	+	-	-
4b	stable passive job reports no significant increase across time	+	+	-	-
5	Change from high strain to no-high strain job results in significant decrease in strain	-	+/-	-	-
6	Change from no-high strain job to high strain job results in significant increase in strain	+/-	+/-	-	-
7	Change from active/passive work to low strain results in significant decrease in strain	+	-	-	-
8	Change from low strain to active/passive work results in significant increase in strain	+	-	-	-
Hypotheses involving amount and type of job change					
9	Groups reporting major changes in work characteristics (i.e., changes from low strain to high strain or vice versa) report more job changes than other groups	+			

Note. + = hypothesis supported; - = hypothesis rejected; +/- = hypothesis partly supported (not all changes significant).

None of the specific hypotheses were supported for the two sickness absence measures. Results were mixed for the two other outcome variables. Hypothesis 5 stated that a change from a high strain job to a no-high strain job would be associated with an increase in well-being. This hypothesis was supported for job dissatisfaction only, and even then for the high strain to active/passive group only (Hypothesis 5 partially supported). Hypothesis 6 stated that a change from a no-high strain group to a high strain job would result in a significant increase in strain. This hypothesis was supported for Depression and Job dissatisfaction: changes from low strain to high strain and from active/passive work to high strain were indeed associated with elevated levels of ill-health. This pattern of results suggests that a change from the no-high strain condition to the high strain condition tends to result in elevated levels of self-reported strain. However, the corresponding positive change (i.e., from the high strain condition to the low strain condition) seems to have much weaker effects on levels of strain. This suggests that the adverse effects of having a high strain job are such that they are not resolved immediately when positive changes occur -- an "accumulation effect" in Frese and Zapf's (1988) terminology.

Hypothesis 7 stated that a change from active/passive work to low strain would be associated with lower levels of strain, whereas the reverse change (from low strain to active/passive work) would be associated with an increasing levels of strain (Hypothesis 8). These hypotheses were supported for Depression only. Thus, it is not the case that the possible detrimental health effects of a prolonged stay in an active/passive job are such that they are not resolved soon after a change to a healthier job. This finding is consistent with Karasek's (1979) position that especially a high strain job has detrimental effects on health, and that these health effects would be less pronounced for the other three job types.

Can change in reported exposure to demands and control be linked to "objective" changes in the work environment? As Karasek's (1979) DC model is an environmental model, it is important to check whether subjectively reported changes in work characteristics can be linked to "objective" changes in the work environment. In the present study significant associations between changes in DC-histories and self-reported job changes over time were found. Further, we found that employees who reported negative changes in self-reported job conditions were more likely to have experienced this change as distressing, compared to workers with positive DC-histories. These findings provide

converging evidence for the assumption that changes in subjectively experienced well-being can at least partly be traced back to corresponding changes in the work environment.

Study limitations and directions for future research. One limitation of the present study is that, in spite of its four-wave longitudinal design, no causal relationships in the strictest sense of the word could be demonstrated. It is certainly suggestive to see that "objective" and self-reported changes in work characteristics are associated with corresponding changes in worker health, but only well-controlled experimental designs with random assignment of participants to experimental and control groups can provide conclusive evidence in this respect. On the other hand, however, it would seem quite difficult to conceive a study on the effects of long-term exposure to various combinations of demands and control in a laboratory setting.

A possibly more important limitation of the present study concerns the choice of dependent variables. These were taken from a more varied set of outcome variables that may to different degrees be linked to the job characteristics included in this study. One indication that not all dependent variables are linked in a similar fashion to the job characteristics studied here is suggested by the finding that our hypotheses received considerably more support for the subjective outcome variables (i.e., depression and job satisfaction) than for the registered sickness absence data (cf. Table 4.6). One explanation for this finding is that sickness absence is a complex measure that may be dependent on other factors than the job characteristics measured in this study. Sickness absence is a multicausal construct influenced by for example age, gender, type of job, behavioural lifestyle variables such as smoking and alcohol intake (Allegro & Veerman, 1998). If this reasoning is correct, the effects of work characteristics on sickness absence are relatively small. Another interpretation of the lack of effects for sickness absence is that job characteristics have an *indirect* effect on sickness absence that could not be detected in this analysis. The effects of demands and control may affect health indirectly, through the psychological outcomes; if so, a longer time interval may be needed to observe these indirect effects (de Jonge et al., 2000).

A related issue is that not all outcome variables included in this study may be considered to represent Karasek's (1979) strain concept equally well. In Karasek's conceptualisation, strain refers to a chronic affective response to a stressful work environment. In this respect, depressive complaints would seem the best representative of

strain; job satisfaction would also seem to include motivational aspects, and cannot be considered a strain indicator per se. Further, as said earlier on, sickness absence may best be considered the result of a wide range of factors which may or may not be related to the work environment: thus, sickness absence presumably reflects the consequences of prolonged work-related stress to a very limited degree. Consequently, the results found for depression should be deemed more important in reference to the strain hypothesis than job satisfaction or sickness absence. If this is correct, it is certainly suggestive to see that our hypotheses received most support for depression, which represents Karasek's strain concept best.

In line with these reservations, it would seem important that future longitudinal research explores more and more varied outcomes in relation to the hypotheses presented in this study. Can the effects reported here be generalized to other populations and outcome variables? Furthermore, these studies should provide a more in-depth exploration of the possible causal links between work and health, examining not only the possible causal effects of work characteristics on worker health, but also possible reverse effects (i.e., does worker health influence (perceptions of) the work environment, Frese & Zapf, 1988; Taris et al., 1998). In addition, the effects of work on “objective” health outcomes seem rather different compared to the effects on subjectively measured health outcomes. Future research should explore the effects on such “objective” measures in more detail, taking into account the effects of non-work related factors.

Practical and theoretical implications. Despite the limitations and issues for future research outlined above, we believe that the present study provides important new insights in the effects of work characteristics on worker health. It extends and enhances our understanding of this relationship in at least three respects. First, this study has demonstrated that Karasek's (1979) strain hypothesis should be refined to account for the effects of having an active/passive job, in addition to the standard distinction between low and high strain jobs. Our results provided evidence that the health consequences of having an active/passive job are somewhere in between those of having a high vs. a low strain job. Second, the present study has demonstrated that there is a clear relationship between subjectively measured changes in health, subjectively reported changes in job demands and control, and “objective” changes in the work environment. Although this relationship lies at

the heart of virtually every study employing Karasek's (1979) DC model, we believe ours is the first that has empirically tested the links between these concepts. Third, the present study has confirmed and further generalized the results presented by Schnall et al.(1998). That study was the first to present evidence on the effects of cumulative exposure to various combinations of demands and control. The present study extended these results by examining other outcome variables in the context of a larger-scale longitudinal study, showing that the effects of job demands and job control vary as a function of the type of outcome variable -- more specifically, of the degree to which an outcome variable corresponds with Karasek's (1979) notion of strain.

On the basis of the results presented in this study, several theoretical and practical implications emerge. From a theoretical point of view it is intriguing to see that different types of DC-histories seem to be differentially associated with various types of health outcomes. These associations can largely be interpreted on the basis of predictions generated by Karasek's (1979) DC model. While previous research has suggested that cumulative exposure to high strain tends to result in negative health outcomes (Bourbonnais et al., 1999; Fenwick & Tausig, 1994; Furda et al., 1994; Janssen et al., 2001; de Jonge et al., 1998; Schnall et al., 1998; Theorell et al., 1990), the present study is the first to explore the effects of exposure to other combinations of job demands and control. Consequently, from a theoretical point of view it seems worthwhile to explore the differential effects of various DC-histories on worker health.

Another implication originates from the link between the psychosocial self-report measures and the “objective” work environment that has been demonstrated in the present study. Our results suggest that working in a high strain job over a prolonged period of time can have detrimental effects on worker health. Job redesign should therefore especially be focused on those who hold a high strain job or on those who transfer to a high strain job. Workers who transfer to a high strain job or who work in a high strain job may need extra attention to improve their health (Taris et al., 1998). Counselling should be aimed at preventing the possible negative effects of the current job and help the worker with making the decisions needed to improve their job satisfaction and health. It should be noted that post-hoc analyses revealed that the detrimental effects of working in a stable high strain job

do not vary with age or years of experience. Thus, it is not the case that "seniors" profit from their surplus of work experience in dealing with the effects of high strain.

Finally, it is noteworthy that our results showed that a change from a high strain job to a less distressing job did in the short term not result in a corresponding improvement in worker health. Thus, the effect of having been in a high strain job seems to have a lasting effect on worker health, even if the work environment changes positively. One explanation for this finding is that the prolonged exposure to high levels of stress and strain has damaged the workers' capacity to recover from job-related fatigue (Kompier, 1988; Meijman & Mulder, 1998; Sluijter et al., 2001).

The most important conclusion that can be drawn on the basis of the present study is that the past seems to matter in determining current health. Cumulative exposure to high job strain has more profound effects on worker health than short-term exposure; the health consequences of having a high strain job are such that these effects do not disappear swiftly after a change to a low-strain job. Such effects cannot be detected using standard modes of analysis (e.g., longitudinal designs in which Time 2 health scores are related to Time 1 health scores and Time 1 job characteristics). In this sense, the current study has shed new light on the long-standing issue of the health effects of job demands and control by offering a new paradigm for examining the effects of job characteristics. We believe that the present approach can be of considerable value to future research.

References

Allegro, J. T., & Veerman, T. J. (1998). Sickness absence. In P. J. Drenth, H. K. Thierry, & Ch. J. De Wolff (Eds.), *Handbook of Work and Organizational Psychology (2nd Ed),* volume 2 (pp. 121-144). East Sussex: Psychology Press.

Ariëns, G.A.M., Bongers, P. M., Miedema, M. C., Wal, G., van der, Bouter, L. M., & Mechelen, W., van. (2001). Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study in occupational setting. *Journal of Occupational and Environmental Medicine*, 58, 200-207.

Bourbonnais, R., Comeau, M., & Vezina, M. (1999). Job strain and evolution of mental health among nurses. *Journal of Occupational Health Psychology, 4*, 95-107.

Doef, M.P. van der, & Maes, S. (1999). The Job Demand-Control(-Support) Model and psychological well-being: A review of 20 years of empirical research. *Work & Stress, 13*, 87-114.

Fenwick, R., & Tausig, M. (1994). The macroeconomic context of job stress. *Journal of Health and Social Behavior, 35,* 266-282.

Frese, M., & Zapf, D (1988). Methodological issues in the study of work stress: Objective vs subjective measurement of work stress and the question of longitudinal studies. In C.L. Cooper & R. Payne (Eds.), *Causes, coping and consequences of stress at work* (pp. 375-411). Chichester: John Wiley & Sons Ltd.

Fienberg, S. E. (1980). *The analysis of cross-classified categorical data* (2nd Ed). Cambridge, MA: MIT Press.

Furda, J., de Jonge, J., le Blanc, P., Meijman, T., Schreurs, P., & Scheenen, J. (1994). Het Demand-control-support model in relatie tot gezondheidsklachten en herstelklachten: Een longitudinale studie. <The Demand-Control-Support model in relation to health complaints and recovery complaints: a longitudinal study>. *Gedrag & Organisatie, 7,* 225-238.

Hoogendoorn, W. E., Bongers, P. M., Vet, H. C. W., de, Douwes, M., Koes, B. W., Miedema, M. C., Ariëns, G. A. M., & Bouter, L. M. (2000). Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective corhort study. *Spine, 25*, 3087-3092.

Janssen, N., & Nijhuis, F. J. N. (2001). Herstel van langdurige vermoeidheid bij werknemers: De invloed van positieve veranderingen in werkkenmerken. <Recovery from long-term fatigue in a working population: the influence of positive changes in work characteristics.> *Gedrag & Organisatie, 14*, 273-290.

Johnson, J.V. & Stewart, W.F. (1993). Measuring work organization exposure over the life course with a job-exposure matrix. *Scandinavian Journal of Work, Environment and Health, 19,* 21-28.

Jonge, de, J., & Kompier, M. A. J.(1997). A critical examination of the Demand-Control-Support Model from a work psychological perspective. *International Journal of Stress Management, 4*, 235-258.

Jonge, de, J., Le Blanc, P. M., Schaufeli, W. B., & van der Linden, S. (1998). Verandering in werkkenmerken in relatie tot verandering in burnout en arbeidstevredenheid.<Changes in job characteristics as related to changes in burnout and job satisfaction> *Gedrag en Organisatie, 11*, 121-134.

Jonge, de, J. Reuvers, M. E. N., Houtman, I. L. D., Bongers, P. M., & Kompier, M. A. J (2000). Linear and nonlinear relations between psychosocial job characteristics, subjective outcomes and sickness absence: baseline results from SMASH. *Journal of Occupational Health Psychology, 5*, 256-268.

Karasek, R. A. (1979). Job demands, Job decision latitude, and mental strain: Implications for Job Redesign. *Administrative Science Quarterly, 24,* 285-308.

Karasek, R. A. (1985). *Job Content Instrument: Questionnaire and user's guide.* Los Angeles: Department of Industrial and Systems Engineering, University of Southern California.

Karasek, R., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life.* New York: Basic Books.

Kasl, S.V. (1998). Measuring job stressors and studying the health impact of the work environment: An epidemiologic commentary. *Journal of Occupational Health Psychology, 3*, 390-401.

Knoke, D., & Burke, P.J. (1980). *Log-linear models*. Beverly Hills: Sage.

Kohout, F. J., Berkman, L. F., Evans, D. A., Cornoni-Huntley, J. (1993). Two shorter forms of the CES-D depression symptoms index. *Journal of Aging and Health, 5*, 197-193.

Kompier, M. A. J. (1988). *Work and Health of City Bus Drivers* ("Arbeid en gezondheid van stadsbuschauffeurs"). Thesis, University of Groningen. Delft: Eburon.

Kristensen, T. S. (1999). Challenges for research and prevention in relation to work and cardiovascular diseases. *Scandinavian Journal of Work, Environment and Health, 25*, 550-557.

Landsbergis, P., & Theorell, T. (2000). Measurement of psychosocial workplace exposure variables. *Occupational Medicine: State of the Art Reviews, 15*, 163-188.

Lange, A., de, Kompier, M., Jonge, J., de, Taris, T, & Houtman, I. (2001). Hoogwaardig longitudinaal vragenlijstonderzoek en het Demand-Control-(Support) Model. <High-quality longitudinal survey research and the Demand-Control-(Support) model> *Gedrag en Organisatie, 14,* 254-272.

Le Blanc, P., de Jonge, J., & Schaufeli, W. (2000). In N. Chmiel (Ed.), *Introduction to Work and Organizational Psychology. A European perspective* (pp. 148-178). Oxford, UK: Blackwell Publishers.

Meijman, T. F., & Mulder, G. (1998). Psychological aspects of workload. In P.J. Drenth, H.K. Thierry, & Ch. J. De Wolff (Eds.), *Handbook of Work and Organizational Psychology (2nd Ed*), volume 2 (pp. 5-33). East Sussex: Psychology Press.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385-401.

Schnall, P. L., Landsbergis, P. A., & Baker, D. (1994). Job strain and cardiovascular disease. *Annual Review of Public Health, 15,* 381-411.

Schnall, P. L., Schwartz, J. E., Schwartz, Landsbergis, P.A., Warren, K., & Pickering, T. G. (1998). A longitudinal study of job strain and ambulatory blood pressure: Results from a three year follow-up. *Psychosomatic Medicine, 60,* 697-706.

Schreurs, P.J.G., Taris, T.W., & Schaufeli, W.B. (1999). Arbeidsbelasting, stress en burnout in de zorg (Work load, stress, and burnout in health organizations). In J. Pool & H. van Dijk (Eds.), *Bouwstenen voor personeelsmanagement in de zorg. Deel 2: Ontwikkeling en duurzame interne inzetbaarheid van personeel* (pp. 113-127). Houten: Bohn, Stafleu en Van Loghum.

Selye, H. (1976). *The stress of life*. New York: McGraw-Hill.

Sluijter, J. K., Frings-Dresen, M. H. W., Beek, A. J., van der, & Meijman, T. F. (2001). The relation between work-induced neuroendocrine reactivity and recovery, subjective need for recovery, and health status. *Journal of Psychosomatic Research,* 50, 29-37.

Taris, T. W. (2000). *A primer in longitudinal data analysis.* Londen: Sage.

Theorell, T. (2000). Job characteristics in a theoretical and practical health context. In C.L. Cooper (Ed.), *Theories of organizational stress* (pp. 205-245). Oxford: Oxford University Press.

Theorell, T., Karasek, R.A., & Eneroth, P. (1990). Job strain variations in relation to plasma testosterone fluctuations in working men-a longitudinal study. *Journal of Internal Medicine, 227*, 31-36.

Wanous, J. P., Reichers, A., E., Hudy, M. J. (1997). Overall job satisfaction: How good are single-item measures? *Journal of Applied Psychology, 82*, 247-252.

5

Different mechanisms to explain reversed effects of mental health on work characteristics

Appeared as:

De Lange, A. H., Taris, T. W., Kompier, M. A. J., Houtman, I. L. D., Bongers, P. M. (2005). Different mechanisms to explain the reversed effects of mental health on work characteristics. *Scandinavian Journal of Work, Environment and Health*., *31*, 3-14.

5.1 Abstract

The number of longitudinal studies reporting evidence for reversed effects from strain on work is growing, but evidence regarding the mechanisms underlying such effects is scarce. In this study, earlier longitudinal findings were reviewed, and the following four mechanisms for reversed effects were proposed that reflect within-person or environmental changes: (i) the rosy perception mechanism, ii) the gloomy perception mechanism, iii) the upward selection mechanism, and iv) the drift mechanism. These mechanisms were tested using structural equation modeling and longitudinal data from a Dutch four-phase study (N = 1588 participants The results revealed that work characteristics and mental health incluenced each other reciprocally and longitudinally. The reversed effects were examined in more detail, and it was found that these could be accounted for by both within-person and environmental change mechanisms. The rosy perception mechanism was found to explain the positive effects from health on job demands; the upward selection mechanism explained the positive (environmental) effects from health on job control; the gloomy perception mechanism explained the reversed (evaluation) effects from health on supervisory social support. No support was found for the drift mechanism.

Mechanisms that may explain the reversed causation are yet poorly understood. The main contribution of the present study lies in the fact that it proposes (a) a conceptual framework with which to analyse the effects from health on work characteristics, and (b) methods for testing these mechanisms. The study revealed that is good reason to pursue research on reversed causality.

5.2 Introduction

One goal of occupational health research is to determine the causal sequence of the relationship between work and well-being (Taris & Kompier, 2003). Most work-stress models, for example, the Demand-Control-Support model (DCS model, Karasek & Theorell, 1990) consider this relationship to be unidirectional. Stressful work, characterized by, for example high demands, low control and low social support, is assumed to lead to such strain complaints as diminished psychological and physical well-being. These *normal causal* relationships have been documented in numerous studies (see de Lange et al., 2003; van der Doef et al., 1999, for reviews). However, the cross-sectional associations between work and strain typically reported in previous research can also be explained by *reversed causal* relationships, in which initial strain complaints influence work characteristics across time. For instance, a tired time-1 employee may perceive his or her time-2 job demands as more demanding compared to a energetic time-1 co-worker. Associations between work and strain can also be explained by bi-directional or *reciprocal causal* relationships in which both normal and reversed causal relationships operate (Hurrell et al., 1998; Tennant, 2001). A recent longitudinal study (de Lange et al., 2004; cf. Chapter 3) found evidence for reciprocal causal relationships between demands, control and social support of supervisors on the one hand, and mental health (depressive mood, job satisfaction and emotional exhaustion) on the other. These relationships were consistent across four time segments covering 3 years.

Although researchers are becoming increasingly aware of the possible reversed effects of mental health on work, such effects are rarely tested. Consequently, it is not known which mechanisms may account for them (de Lange et al., 2003, Dormann & Zapf, 2002). To enhance the understanding of reversed causation, in our present study, we have addressed the evidence and possible explanations for the effects of mental health on psychosocial work characteristics. First, we have briefly reviewed the evidence for and prevalence of these reversed effects and then considered four possible mechanisms that may account for reversed causation. Thereafter the results of our empirical testing of the mechanisms have been presented.

Prevalence of reversed or reciprocal effects. In reviewing the evidence for reversed effects, we focused on studies that measure the same variables repeatedly among the same

panel of respondents, as only such studies can test reciprocal effects. Zapf, Dormann and Frese (1996) reviewed 39 longitudinal organizational stress studies and examined whether these studies tested normal or reversed effects. They found that 15 of these 39 stress studies explored reversed causal effects. Seven of thefifteen studies (47%) provided evidence for reversed causal relationships. Typical examples are Kohn and Schooler (1982), who found a positive reversed effect of time-1 anxiety on time-2 self-reported time pressure (and not vice versa), and Marcelissen et al. (1988), who reported a negative reversed effect of health complaints (e.g. strain, worry, and diastolic blood pressure) on co-worker support (and not vice versa).

More recently, four longitudinal studies (Bakker et al., 2000; de Jonge et al., 2001; Leiter et al., 1996; Mills & Huebner, 1998) found effects of burnout levels on the perception of work characteristics. Bakker et al. (2000) found positive effects of time-1 depersonalization on time-2 frequency and self-reported intensity of patient demands (but not vice versa), whereas de Jonge et al. (2001) reported a positive effect of emotional exhaustion on job demands (and not vice versa). Similar effects were found by Leiter and Durup (1996), who reported evidence for a reversed relationship between emotional exhaustion, work overload and supervisory support, and Mills and Huebner (1998), who reported reversed effects of burnout on occupational stressors.

Longitudinal research also revealed effects of general distress or depressive complaints on the perception of work characteristics. Moyle (1998) found positive effects of time-1 distress on the perception of time-2 demands, whereas Garst, Frese and Molenaar (2000) found, next-to normal causal effects, effects from time-1 strain (depressive complaints, psychosomatic complaints, irritation and worrying) on the perception of time-2 work stressors (job insecurity, time pressure, organizational problems, social stressors and uncertainty). Three other longitudinal studies (Glickman et al., 1991; Prosser et al., 1997; Taris et al., 1998) found evidence for effects of prior depression on the perception of time-2 job characteristics. Finally, Taris (1999) found effects of mental health status (depression, self-esteem and general health) on the perception of job characteristics (e.g., variety, autonomy and job security). On the basis of the results of these studies, it can be concluded that the evidence for lagged reciprocal relationships between work and (mental) health is

accumulating. In other words, not only do work characteristics affect (mental) health, but (mental) health affects work characteristics as well.

How can these reversed effects be explained? Currently, little theorizing on possible underlying mechanisms is available. Figure 5.1 illustrates four mechanisms that we believe may be responsible for the reversed causal effect of mental health on work. Theoretically, reversed effects of mental health status can be due to either *real* positive or negative changes of the work environment (environmental changes, corresponding with path *b* in Figure 5.1) or to changes of the *evaluation* of the *same* work environment (within-person changes; path *a* in Figure 5.1) or due to combinations of these.

Therefore, we have hypothesized that reversed causation can be explained by different processes within different subgroups. One way to explore these processes is to compare employees who remain in the same job with job changers. We assumed that reported DCS changes of employees working in the same psychosocial work environment (stayers) more likely reflect perceptual or within-person reversed effects than do DCS changes reported by workers who transfer to a different job. Furthermore, reported DCS changes of job changers will more likely reflect reversed (real) environmental effects of their mental health status than the changes reported by stayers. This is not to say that it is impossible that stayers and job changers experience combinations of these mechanisms. For example, an unhealthy job changer may transfer to a more-positive work environment (with more real job control) but, at the same time, may also have a rosier perception of the amount of support provided by his or her new colleagues. Since reversed causation implies an effect of time-1 mental health, we believe it is important to compare time-1 healthy versus unhealthy workers with respect to their DCS changes across time. In the discussion that follows, we present these mechanisms in greater detail.

Changes in the evaluation of the same job. We assumed that time-1 mental health status may change one's evaluation of the same job across time in several ways. First, *positive* re-evaluations of work characteristics can be explained by assuming that workers color their perceptions of the work characteristics in a rosier light (the *rosy perception* mechanism, *Mechanism 1* in Figure 5.1). For instance, time-1 healthy workers can have more energy to work faster (compared with less energetic co-workers), and this energy can lead them to re-interpret their job demands as less demanding across time (Fletcher, 2003).

Positive re-interpretation effects may also be explained by the fact that *unhealthy* employees have changed their aspirations and cognitions in order to accept their unfavorable work situation or that they have colored their perceptions in line with their expectations of the work environment (e.g., as a result of a "cognitive dissonance" effect; Festinger, 1957). Employees who have realized that they will not be able to improve their job or find a better job may have accepted their situation and may also have colored their perception in a rosier light ("after all, this job is not so bad"). In other words, we believe this rosy perception mechanism is accepted when (un)healthy stayers report significantly more favorable work characteristics across time (in line with the assumptions of the DCS model: significantly fewer job demands or more job control, social support (*Mechanism 1 in Figure 5.1*)).

Employees may also perceive their work environment as more *negative* across time. Negative re-evaluation effects can be explained by the assumption that *healthy* workers perceive the same job as gloomier across time. In these situations, employees may even speak of "the daily grind of work". According to the person-environment (P-E) fit theory (Semmer, 2003, p. 86), these negative evaluation effects can be explained by a discrepancy between what the worker (P) wants (e.g., a more-challenging work environment) and what the worker gets in his or her job (E). For instance, a teacher who has taught the same course for several years may perceive his or her job as less challenging than when when he or she first taught the course.

Zapf et al. (1996) labeled the negative re-interpretation effect for *unhealthy* workers as the "true strain-stressor process", whereas Spector et al. (2000) spoke of the "stressor creation hypothesis" (in the context of negative affectivity). Since also other strain-stressor effects may operate (cf. Figure 5.1), we re-label this explanation as the *gloomy perception* mechanism. Unhealthy employees (e.g., depressive workers) can also evaluate their environment more negatively and thus report less favorable work characteristics. These unhealthy workers have a more gloomier perception of reality. We believe the gloomy perception mechanism is supported when (un)healthy stayers report a significant decrease in favorable work characteristics (i.e., significantly more job demands, or less job control, social support) across time (*Mechanism 2* in Figure 5.1).

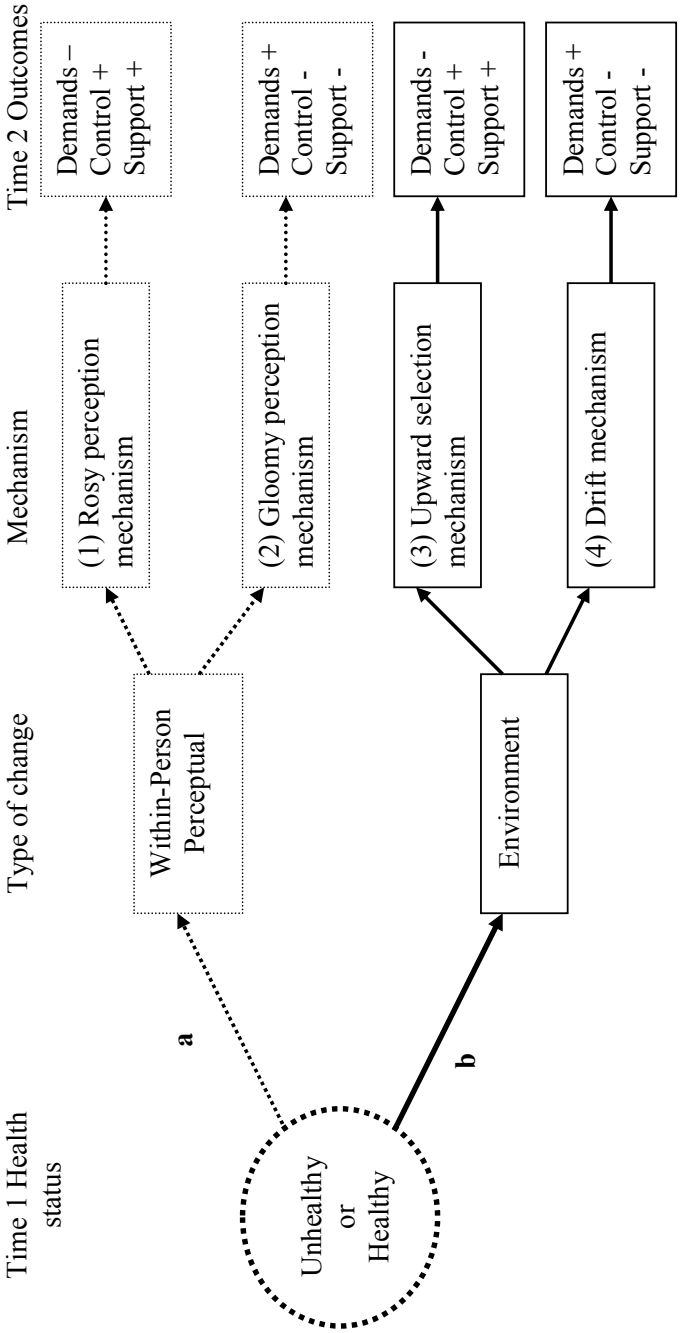


Figure 5.1

Four mechanisms for reversed effects of mental health on work

Environmental changes. Health status can also result in *real* changes of the work environment. One explanation for positive changes in the work environment draws on the occurrence of promotions of *healthy* workers. In this *upward selection* process, relatively healthier workers get promoted to more-challenging jobs (possibly experiencing more job control) or a less stressful job (with fewer job demands and more job control and social support; Ganster & Schabroeck, 1991, p. 263). Job changes may also have positive environmental outcomes for *unhealthy* workers. E.g., unhealthy workers may have successfully looked for *refuge* in a different job (Garst et al., 2000) and, accordingly, also moved upwards to a more favorable work environment. These unhealthy employees organize their jobs or positions differently or transfer to a less stressful job in order to create a less demanding work environment, characterized by, for instance, fewer demands or higher control and social support). We believe the upward selection mechanism is supported if a job change of a(n) (un)healthy worker results in a more-favorable work environment (i.e., significantly fewer job demands or significantly more job control and social support; *Mechanism 3* in Figure 5.1).

Health effects can also result in *negative* changes of the work environment, as described in the *drift* mechanism of Zapf, Dormann and Frese (1996; Frese, 1985). According to this mechanism, workers with poor health drift to less favorable jobs. For instance, if for any reason the health of a worker deteriorates he or she becomes unable to meet current job demands, the job has to be changed or the worker will leave the job (and find a less-favorable job). This downward selection process (Ettner & Grzywacz, 2001) can be understood as a derivative of the familiar healthy worker effect (Marmot & Madge, 1987), namely, the assumption that only healthy workers are able to retain a certain job implies that unhealthy workers are *un*able to do so. Finally, negative work environment changes reported by *healthy* workers can also be explained from a downward selection effect or drift. For example, the new job is not what the employee expected or he or she finds it hard to cope with the new job demands. We believe the *drift* mechanism is supported if (un)healthy job changers report a significant increase in negative work characteristics (i.e., more job demands, and less job control, social support (*Mechanism 4* in Figure 5.1).

Test of the four mechanisms for reversed causation. Using our distinction between environmental changes and perceptual changes of the same work environment, we found the following four explanations for possible reversed effects of mental health on work, namely: i) a rosy perception mechanism; ii) a gloomy perception mechanism; iii) an upward selection mechanism; and iv) a drift mechanism (cf. Figure 5.1). One earlier study (Garst et al., 2000) has tested several mechanisms for reversed effects [i.e., the refuge mechanism, the drift mechanism, and "positive or negative direct effects" (comparable with our environmental mechanisms)] and found support for the refuge (an upward selection) mechanism and positive direct effects mechanism. However, one important limitation of this study was that the authors did not distinguish between different subgroups (e.g., stayers vs. job changers), whereas it would seem likely that several reverse causation mechanisms might be more valid for certain subgroups. For example, we assumed that re-evaluation or within-person mechanisms would be more likely for unhealthy or healthy workers who remain in the same job (stayers), whereas environmental change mechanisms may be more visible within subgroups that actually transfer to different jobs (job changers). Furthermore, the current theory concerning reversed causation indicates that unhealthy workers report relatively more negative (re-evaluation or environmental) changes in their work characteristics compared to healthy workers [e.g., the drift mechanism of Zapf et al. (1996) or stressor creation hypothesis of Spector et al. (2000)], but we do not yet know whether this is true. In addition, earlier research in occupational health psychology has also emphasized the importance of subgroup analysis (cf. Taris & Kompier, 2003, de Lange et al., 2002, de Lange et al., 2003; Frese & Zapf, 1988), as it allows exploration of multiple (reversed) causation mechanisms simultaneously. Consequently, in this study, we tested the different reversed causation mechanisms using subgroup analysis (distinguishing between healthy versus unhealthy workers and stayers versus job changers).

5.3 Method

Study population

We conducted our study within the framework of the four-phase prospective Dutch cohort study on musculoskeletal disorders, absenteeism, stress and health (SMASH).

Altogether 1789 employees working in 34 companies, located throughout The Netherlands, participated (see de Lange et al., 2002, for more information). Both blue-collar jobs and white-collar jobs were selected. In each phase (i.e., 1994, 1995, 1996, and 1997) the respondents completed a self-administered questionnaire, tapping concepts such as general working conditions, changes in the workplace, psychosocial work characteristics, psychosocial and physical health, and background factors.

Attrition. The response rates were relatively high and varied from 84% (N = 1742) at baseline to 85% (N = 1473) at the third follow-up measurement. A non-response analysis revealed that drop-outs tended to report more strain and less control across time, a common phenomenon in longitudinal research (see Taris, 2000, for a review). As a consequence, our results may reflect an underestimation of the true reversed effects of low mental health, as the relatively unhealthy workers dropped out across time.

Measures

Job demands. Job demands were measured using a 5-item Dutch version of Karasek´s (1985) Job Content Questionnaire (e.g., ”My job requires working very fast”, 1 = strongly disagree", 4 = "strongly agree"). The reliability (Cronbach’s alpha) of this scale varied from 0.65 to 0.72 across the phases of the study (median alpha= 0.71).

Job control. Consistent with Karasek's (1985) conceptualization, job control was measured as the mean of two scales. *Skill discretion* was measured using a 5-item scale (e.g., ”my job requires that I learn new things"), and *decision authority* was measured using a 3-item scale (e.g., “My job allows me to take many decisions on my own”, 1 = "strongly disagree", 4 = "strongly agree"). The reliabilities of the job control scale ranged from 0.81 to 0.83 (median alpha = 0.83).

Social support of supervisors. Supervisors’ social support was measured using a 4-item Dutch version of Karasek´s (1985) Job Content Questionnaire (e.g., ”My supervisor pays attention to what I say ”, 1 = "strongly disagree", 4 = "strongly agree"). The reliability (Cronbach’s alpha) of this scale varied from 0.82 to 0.88 across occasions (median alpha= 0.86).

Mental ill-health. In line with Warr (1987, 1994), mental ill-health was measured in terms of depressive mood. Warr (1987, 1994) suggested that ‘depression to enthusiasm’ is

one of the central affective dimensions of job related mental health. Depressive mood is a common indicator of the 'depression' dimension of job-related mental health (cf. Van Horn et al., 2004) and was measured using an 11-item Dutch version of the CES-D scale (Radloff, 1977, Kohout et al., 1993; e.g., "The past two weeks I felt lonely", 1 = "hardly ever or never", 3 = "much or most of the time"; higher scores reflect higher levels of depressive mood). The reliability varied from 0.81 to 0.87 across occasions (median alpha = 0.85).

Covariates. Age, gender (0=male, 1=female), and education (five categories, ranging from primary or lower education to college or university education) were used as covariates in the analysis, because these variables are often related to our outcome variables (e.g., Karasek & Theorell, 1990; de Jonge & Kompier, 1997). We did not formulate substantive hypotheses concerning their effects. In addition, we controlled for time-2 depressive mood, as we wanted to control for the possibility that the mental health status of the workers had changed during the follow-up period and affected the (perceptions of) time-2 work conditions differently from the time-1 phase.

Subgroup analyses

As already discussed, the reversed causation mechanisms hypothesize different effects for healthy and unhealthy stayers (merely indicating possible evaluation effects) and (un)healthy job changers (merely indicating possible environmental effects).

Determining the job changers and stayers. On all four occasions of the study, the employees were asked whether they had changed jobs over the preceding 12 months ["yes" for job-change groups and "no" for stayers] and whether their colleagues and supervisors changed over the preceding 12 months ("*no*" for stayers). As a consequence, our stayers reported no job changes and no changes in their colleagues and supervisors and therefore have a rather stable work environment.

To maximize the utility of the data, we selected all possible job changers and stayers across the four phases of the study and transformed their data into a 2-phase design, resulting in a before (New time-1: N_{T1}) and after (New time-2: N_{T2}) job-change measurement. For the stayers the N_{T1} and N_{T2} measurements were based on the first two phases, whereas for the job-change groups these measurements were based on the first two

phases (group 2), the second and third phases (group 3), and the third and fourth phases (group 4) of our data. Subsequently, the data of these job-change groups (2, 3 and 4) were pooled, the result being a single data set with a pre- and post-change measurement for both the stayers and the movers.

Classifying (un)healthy stayers, job changers. Using the depressive mood scores on N_{T1} and N_{T2} (using the median split method: median value= 1.45) we classified healthy (Mean N_{T1} = 1.14, *SD* = .13) versus unhealthy (Mean N_{T1} = 1.68, *SD* = .23) employees. These groups differed significantly in their average depressive mood scores, the degree of difference indicating sufficient contrast between the groups. Subsequently, the health status and the job-change information (stayer or job changer) were used to classify healthy versus unhealthy job changers and stayers.

After the listwise deletion of missing values, the sample included 1588 employees (66% male; average age at baseline 35.9 (*SD* = 8.7) years for the stayers and 34.0 (*SD* = 8.5) years for the job changers, The number of participants in each of the four groups was 161 for the unhealthy job changers, 88 for the healthy job changers, 804 for the unhealthy stayers, and 535 for the healthy stayers.

Statistical analysis

Structural equation modeling (SEM, Jöreskog & Sörbom, 1993) was used to test normal and reversed causal effects between job demands, job control, social support of supervisor and depressive mood across time. To examine the different causal relationships, we first tested a baseline model versus several nested (competing) models. The models were as follows:

- M_0 or *baseline model*: Including temporal stabilities and synchronous (within-phase) effects of variables across time and controls for the influence of covariate and used as the reference model.
- M_1 or *normal causation model*: M_0 being extended with cross-lagged paths from the new time-1 demands, control and social support of supervisors (hereafter, DCS) dimensions to the new-time 2 depressive mood.
- M_2 or *reversed causation model*: M_0 being extended with cross-lagged paths from the new time-1 depressive mood to the new time-2 DCS dimensions.

- M_3 or *reciprocal causation model*: M_0 being extended with reciprocal cross-lagged paths (regular paths from model 1 and the reversed paths from model 2).

Table 5.1 presents the fit indices for the baseline model and the competing structural models. This table shows that all structural models presented satisfactory fit indices (NNFI and GFI $\geq$ 0.90, RMSEA $\leq$ 0.05; Byrne, 2002). Moreover, we tested the chi-square differences for the nested structural models versus the baseline model (Table 5.1, column 6). This analysis revealed whether the more complex models (i.e., $M_{1, 2, 3}$) had a better fit than the baseline model without lagged relationships between work and mental health (M_0). As Model 1, 2, and 3 all fit the data significantly better than the baseline model, we also tested the chi-square difference between Model 3 (the reciprocal causation model) and Model 1 (normal causation model) and Model 2 (reversed causation model; column 7 in Table 5.1).

Table 5.1

Fit indices for the stability model versus the nested (competing) causal structural models (N=1216)

Model	χ^2	df	NNFI	GFI	RMSEA	$\Delta\chi^2$ compared to M_0	$\Delta\chi^2$ compared to M_3
Baseline (M_0)	34.44**	12	.96	.99	.039		
Normal (M_1)	18.55*	9	.98	1.00	.029	15.89**	16.82**
Reversed (M_2)	17.26*	9	.98	1.00	.027	17.18**	15.53**
Reciprocal (M_3)	1.73	6	1.02	1.00	.00	32.71**	

Note. * = $p < .05$, ** = $p < .01$, NNFI = Non-Normed fit index, GFI = Goodness of fit index, RMSEA = Root-mean-square error of approximation.

Table 5.1 shows that the reciprocal causation model (M_3) presented the best fit for the data, not only in terms of the fit indices, but also relative to the three competing models. Significant *normal* negative cross-lagged effects were found from time-1 social support of supervisors to time-2 depressive mood (ß = -.06; p <.05). A significant positive *reversed* cross-lagged effect was found for time-1 depressive mood on time-2 demands (ß = .09; p < .05). In addition, a significant *reversed* negative cross-lagged effect was found for time-1 depressive mood on time-2 social support of supervisors (ß = -.06; p < .05).

To test the four different reverse causation mechanisms, we performed a separate 4 (group: healthy stayers versus unhealthy stayers versus healthy job changers versus unhealthy job changers) x 2 (time; N_{T1} versus N_{T2}) analysis of covariance (ANCOVA) for each work characteristic, with time as a within-participants factor, group as a between-participants factor, and age, gender and education as covariates. A significant group x time effect would indicate that the across-time development of the work characteristics differed as a function of group. If so, follow-up analyses were performed to examine whether this change was in line with one of the four mechanisms.

5.4 Results

Table 5.2 presents the means, standard deviations and correlations for the New time-1 (N_{T1}) and time-2 (N_{T2}) variables separately for the job changers and the stayers. The results of a two-group (stayers versus job changers) structural equation analysis showed that the null hypothesis, that the correlations among the variables were the same for the stayers and the job changers, had to be rejected [χ^2 (50) = 178.12, p < .01]. As at least part of the correlations for these groups differed significantly, the reversed causation mechanisms had to thus be examined separately for each group.

Evidence for one or more reversed causation mechanisms? To test the four reversed causation mechanisms, we compared the across-time development of the work characteristics for the four groups (i.e., healthy job changers, unhealthy job changers, healthy stayers and unhealthy stayers). Table 5.3 presents the means and standard deviations of the work characteristics as a function of time and group. As this table shows,

there was only a significant main effect of time for demands [$F(1, 1250) = 5.28$, $p < .05$]. Overall, the data showed a significant decrease in demands across time. The means for control and supervisory social support were stable across time.

Main effects of group were found for demands [$F(3, 1250) = 4.78$, $p < .05$], control [$F(3, 1255) = 2.63$, $p < .05$], and the social support of supervisors [$F(3, 1243) = 5.85$, $p < .01$]. Tukey's LSD test revealed that the pattern of effects was similar across groups, with the unhealthy subgroups reporting relatively more negative outcomes in terms of demands, control and social support of supervisors and the healthy subgroups reporting more positive outcomes. More specifically, the unhealthy job changers report the highest level of N_{T2} demands and the lowest level of N_{T2} social support of supervisors in comparison with the other subgroups, whereas the unhealthy stayers report the lowest level of control.

Significant interaction effects between time and group were found for demands [$F(3, 1250) = 2.98$, $p < .05$], control [$F(3, 1255) = 3.86$, $p < .01$], and social support of supervisors [$F(3, 1243) = 4.04$, $p < .01$]. Table 5.3 shows the means for these interaction effects. To interpret these effects, we tested the time trends for each group separately (significant effects are highlighted with '[a]' in Table 5.3; the F-values are presented below). The effects for demands, control and social support follow with reference to the four mechanisms.

Table 5.2

Correlations, means and standard deviations for the study variables of the stayers (correlations in upper diagonal, N = 1006) versus the job changers (correlations in lower diagonal, N = 210)

	Stayers		Job changers												
Variables	*M*	*SD*	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1 Age[a]	35.83	8.65	33.96	8.48	-	-.16	-.03	.03	.12	.04	-.05	.03	.12	.03	-.02
2 Gender	1.34	.47	1.30	.46	-.28	-	.11	.02	-.24	.01	.13	.01	-.17	.05	.11
3 Education[b]	2.68	1.12	2.89	1.16	-.04	.24	-	-.06	.21	-.03	-.01	-.06	.17	.00	.00
New Time 1															
4 Demands	2.59	.48	2.59	.48	.04	.05	.01	-	-.03	-.18	.13	.56	-.02	-.11	.13
5 Control	2.80	.49	2.84	.48	.13	-.12	.27	-.08	-	.24	-.17	-.03	.69	.14	-.15
6 Support supervisor	2.72	.53	2.63	.58	-.16	.02	-.01	-.21	.36	-	-.10	-.10	.19	.51	-.12
7 Depression	1.32	.33	1.31	.29	.01	.12	.04	.18	-.17	-.26	-	.15	-.15	-.10	.49
New Time 2															
8 Demands	2.55	.50	2.62	.48	.09	.02	.00	.47	-.10	-.13	.16	-	-.06	-.21	.18
9 Control	2.85	.47	2.97	.47	.03	-.05	.33	-.08	.53	.18	-.12	-.17	-	.31	-.18
10 Support supervisor	2.64	.59	2.71	.61	-.16	.02	.04	-.12	.16	.33	-.19	-.22	.23	-	-.17
11 Depression	1.32	.32	1.34	.34	.03	.05	-.01	.08	-.19	-.23	.55	.30	-.25	-.24	-

Nb. [a] 0 = female and 1 = male; [b] 1= primary education or lower; 2 = lower vocational education; 3 = secondary education or middle vocational education; 4 = higher vocational education; 5 = college/university education; correlations of .≥ .09 are significant at $P<.05$

Table 5.3

Means and standard deviations (in brackets) of the outcome variables as a function of time and group

Variables	Group 1: Unhealthy job changers		Group 2 : Healthy job changers		Group 3: Unhealthy stayers		Group 4: Healthy stayers		MANOVA *F*-values		
	N_{T1}	N_{T2}	N_{T1}	N_{T2}	N_{T1}	N_{T2}	N_{T1}	N_{T2}	Time	Group	Time x Group
Demands	2.60 (.04)	2.64 (.04)	2.58 (.05)	2.55 (.05)	2.64 (.02)	2.55[a] (.02)	2.52 (.02)	2.48[a] (.03)	*F* (1, 1250) = 5.28*	*F* (3, 1250) = 4.78*	*F* (3, 1250) = 2.98*
Control	2.83 (.04)	2.94[a] (.04)	2.84 (.05)	2.99[a] (.05)	2.81 (.02)	2.84 (.02)	2.88 (.02)	2.89 (.02)	*F* (1, 1255) = 3.17, *ns*	*F* (3, 1255) = 3.86**	*F* (3, 1255) = 2.63*
Social support of Supervisors	2.53 (.05)	2.64 (.05)	2.85 (.06)	2.86 (.07)	2.70 (.02)	2.64[a] (.02)	2.77 (.03)	2.67[a] (.03)	*F* (1, 1243) = .38, *ns*	*F* (3, 1243) = 5.85**	*F* (3, 1243) = 4.04**

Note. *= $p < .05$, ** = $p < .01$; *F*-values after controlling for age, gender, education and depressive mood T2; [a] = significant Time trend for subgroup: difference between N_{T2} and N_{T1} scores for particular subgroup; *ns*= not significant.

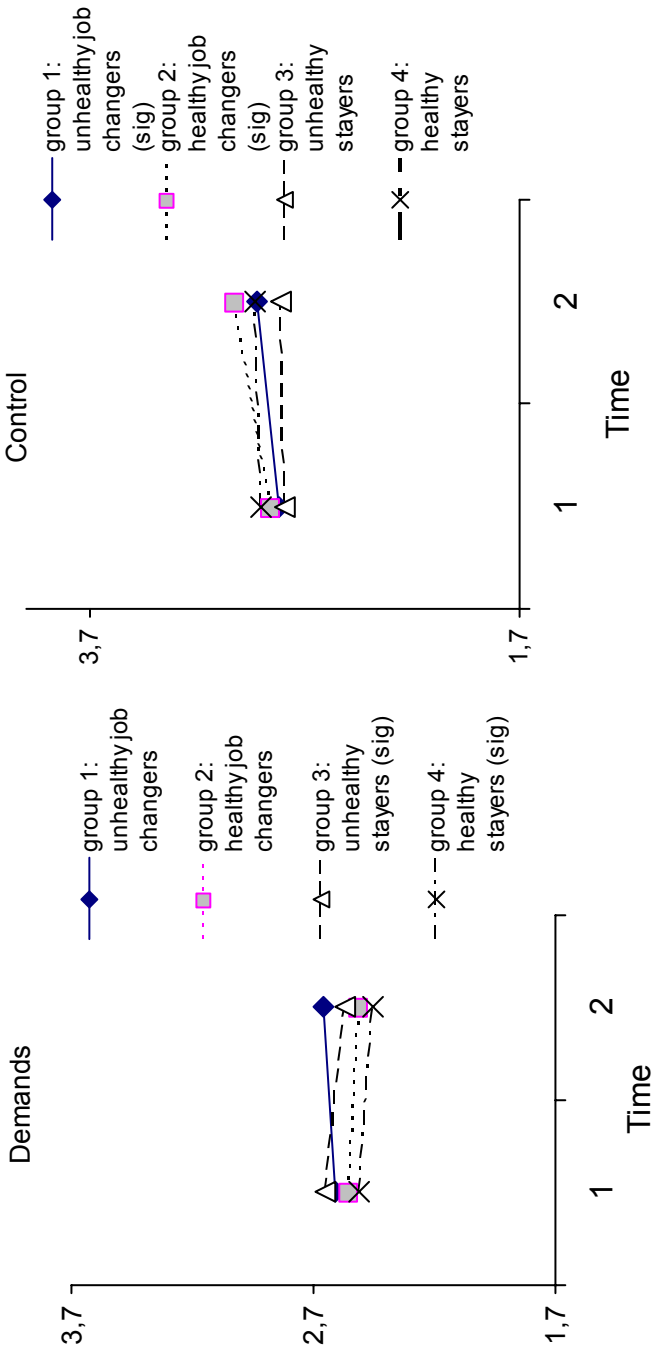
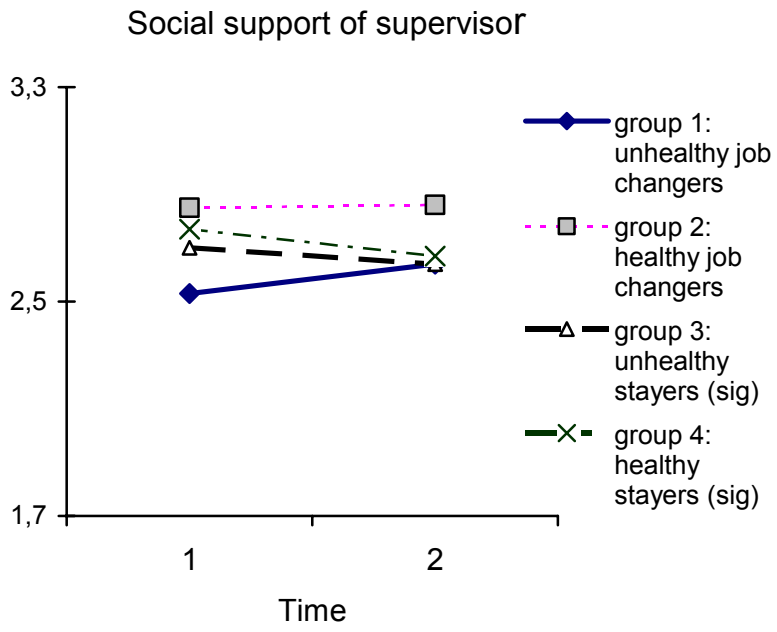


Figure 5.2

Changes in demands, control and social support of supervisor for the different subgroups across time (N_{T1} and N_{T2}).;Note. (Sig)= significant differences in means across time for the particular subgroup (associated *F*-values are presented in text)



-Figure 5.2 continued-

Changes in demands, control and social support of supervisor for the different subgroups across time (NT1 and NT2).
Note. (Sig)= significant differences in means across time for the particular subgroup (associated F-values are presented in text).

Support for different mechanisms

Within-person or evaluation mechanisms. The significant group x time interaction effects for social support of supervisors and demands support the mechanisms that reflect evaluation effects. Figure 2 shows that only the unhealthy and healthy stayers (but not the job changers) reported significant differences in demands and social support of supervisors across time. The unhealthy [$F(1, 628) = 16.30$, $p < .01$] as well as the healthy [$F(1, 439) = 8.65$, $p < .01$] stayers reported a significant decrease in job demands across time. Both healthy and unhealthy workers perceive their job demands more positively, indicating a *rosy perception* mechanism as they remained in the same job.

The significant effects for supervisory social support suggest negative re-evaluation effects. Both the unhealthy and the healthy stayers reported significantly less supervisory

support across time [$F(1, 625) = 8.00$, $p < .01$, and $F(1, 436) = 11.31$, $p < .01$, respectively]. Since the employees´ work situation did not change (i.e., they worked with the same supervisor), it is plausible that prior health status resulted in within-employee changes. Thus the significant decrease in social support indicates a *gloomy perception mechanism* for the (un)healthy workers.

Environmental mechanisms. The significant group x time effect for control revealed some support for environmental change mechanisms. More specifically, Figure 2 shows that the healthy and unhealthy job changers reported significant positive increases in their scores on control across time [$F(1, 145) = 5.54$, $p < .05$, and $F(1, 81) = 14.41$, $p < .01$, respectively]. Hence, both the unhealthy and the healthy job changers obtained more job control in their new job. These results indicate an *upward selection mechanism* for the unhealthy employees (i.e., they successfully looked for refuge in a new job) and the healthy employees (who may have changed to a new job with more job control). However, no support was found for the drift mechanism.

In summary, in addition to normal effects, our results provided evidence for reversed effects of depressive mood on the perception of work characteristics across time. The time-1 healthy workers reported relatively more time-2 positive work outcomes than the unhealthy workers (both the changers and the stayers). Furthermore, the reversed lagged effects of mental health on demands and social support was consistent with two within-person mechanisms, namely, the rosy perception mechanism and the gloomy perception mechanism. Finally, the reversed lagged effects of mental health on job control are consistent with an upward selection mechanism. No support was found for the drift mechanism.

5.5 Discussion

In this study, we attempted to shed more light on the mechanisms underlying reversed causation effects (i.e., effects of health status on work characteristics) in the context of a two-phase study among 1588 Dutch workers. We examined 1-year across-time reversed effects of depressive mood on psychosocial work characteristics and provided evidence for lagged effects of depressive mood on work that were in line with three reversed causation mechanisms. The results provided some support for both within-person and environmental

change mechanisms. More specifically, the results for the stayers pointed at the following within-person change mechanisms: i) the rosy perception mechanism (healthy and unhealthy workers perceived their job demands as more positive across time) and ii) the gloomy perception mechanism (unhealthy and healthy workers perceived the same supervisors as less supportive). In addition, the reversed effects for job changers were in line with the upward selection mechanism (unhealthy and healthy workers have successfully transferred to a less stressful work environment). Consequently, our data suggest different reversed causation mechanisms in explaining the reversed effect of mental health on work across time.

Study limitations and recommendations for future research

Before discussing the implications of our findings, we must first address the most important limitations of our study. First, the findings were entirely based on self-reports. Thus our results may have been subject to biases (e.g. due to personality traits such as negative affectivity; Frese & Zapf, 1988; Kristensen, 1996; Schnall et al., 1994). It would seem possible that not controlling for negative affectivity has resulted in relatively high inter-correlations among the variables. Some researchers even claim that most of the variance in cross-lagged relations between work characteristics and strain (measured by surveys) can be fully explained by negative affectivity (Brief et al., 1988). Initially, we decided not to control for negative affectivity in our analyses as its moderating effects of are not consistently found and it is still unclear what the exact impact is of partialling it out (Semmer, 2003; Spector et al., 2000; Karasek et al., 1998). To examine the possible impact of negative affectivity on our results, we conducted a post-hoc analysis. This analysis showed that the effects of depressive mood on work characteristics reported in our study remained significant when negative affectivity was controlled. Thus it appears when controlling for negative affectivity did not severely bias our findings.

A second limitation follows from the longitudinal design of this study. Although longitudinal data are potentially much better suited for studying causal processes than cross-sectional data are (Taris, 2000), whether this benefit is fully utilized depends on the degree to which the time lag between the different phases suits the process and etiology of the relationship between the research variables under study (de Lange et al., 2004). For instance, the work characteristics of the job changers were measured an average of 6 months before and after the job change. Some previous research has shown that the first

impact of job transition may be a 'reality shock' or 'honey-moon effect' (Frese & Zapf, 1988) that may result in more extreme effects (which disappear after one has gotten used to the new job). At this point we do not know how long such effects may last. As we only employed a 1-year time lag we do not know whether the results of the job changers are still under the influence of such a "novelty phenomenon", or whether its impact has long vanished. Consequently, it is hard to assess whether our results present an under- or overestimation of the true reversed effects as a result of the time lag chosen. Multi-wave designs with short intervals between the waves might be of more value in this respect. On the other hand, a problem of multi-wave designs is the drop-out of respondents across time. For example, our drop-outs reported significantly more strain compared to the response group (indicating a restriction of range), which indicates that the results found may reflect an underestimation of the true reversed causal lagged effects of mental health on work characteristics. Although it seems paradoxical, future research should try to follow-up these relatively more unhealthy drop-outs across time (do they drift off to a more negative work environment?).

A third limitation of the present study concerns the choice of the data for the group of stayers. The data for the pre- and post-test of the stayers were obtained at the Time 1 and Time 2 waves. However, similar data could also have been obtained for the T2-T3 or T3-T4 intervals. Would the same results have been obtained, had we chosen different measurement occasions for the stayers? To test whether our findings were dependent on the choice of the measurement occasions for the stayers group, we repeated our analyses for a different selection of measurement occasions (based on the T3-T4 interval). Comparison of the aforementioned results and the new results revealed no significant differences. Thus, it appears the findings were not seriously affected by the choice of measurement points for the stayers.

Another limitation of the present study is that we could not distinguish between voluntary (self-initiated) and involuntary (other-initiated) job changes. It would seem likely that the type of job change influences the results of these changes. For example, Kalleberg and Mastekaasa (2001) showed that a self-initiated job change was associated with positive work outcomes, while an employer-initiated job change was linked with negative outcomes (cf. van der Velde & Feij, 1995, for similar results). We could not control for these processes and were therefore unable to study their possible impact. It is possible that the

positive outcomes for the job changers found in this study can be attributed to the fact that most of the job changes were self-chosen. It is therefore important that future research distinguishes between self-initiated or other-initiated job changes in testing the explanations for reversed effects that involve real job changes, as some of the mechanisms discussed here assume particular types of job changes. For example, Zapf et al.'s (1996) drift hypothesis seems to assume that many of the changes that lead to worsening of the work environment are involuntary and initiated by others. Conversely, Garst et al.'s (2000) refuge mechanism (an example of an upward selection mechanism) suggests that self-initiated changes are of primary importance; in this mechanism, unhealthy workers actively seek to improve their job characteristics. Thus, it would seem desirable to examine whether particular types of job changes can be linked to particular reverse-causality mechanisms.

In addition, we recommend future research to collect more (qualitative and objective) information about the type of job transfers and the work environment of the stayers to further disentangle the different reversed causation mechanisms. Post-hoc analyses of our job changers revealed that the majority of the healthy as well as the unhealthy job changers reported job transfers to comparable jobs. More specifically, of the healthy job changers 73.3% reported that the new job was comparable to their former job, compared to 76.1% of the unhealthy job changers. Consequently, we cannot conclude that the job transfers resulted in significant different jobs, but we need more information about the type of job transfer to draw stronger conclusions for this subgroup. In addition, we have good reason to believe that the results of our selected stayers (with a stable work environment) provided more information about perceptual reversed effects compared to the job changers, but we cannot fully exclude the possibility that the stayers did experience real changes in their work environment (like a supervisor that provided less support across time) and that the job changers did not experience perceptual effects (for example perceive their new supervisor more positively in line with their expectations).

Study implications

Presumably the most interesting finding of our study is that not less than three out of the four reverse-causation mechanisms received some support: only the drift hypothesis of Zapf et al. (1996; assuming that unhealthy and healthy workers drift to worse jobs) was not supported. One explanation for the absence of support for this mechanism is that workers who voluntarily accept another job because they expect to end up better off, will presumably find it difficult to admit that they are worse off. Denial of the adverse consequences of transferring to another job may thus be considered a self-serving mechanism that protects one's self-esteem (Baumeister et al., 1998). It is also possible that the drop-outs in this study (with more strain complaints) would provide more evidence for this mechanism.

Regarding the mechanisms that were supported, it is interesting to see that none of these received strong support; all three mechanisms are supported for only one of the three work characteristics included in this study. This suggests that there is not one mechanism in particular that stands out as the most important explanation for effects from strain on work characteristics. Further, it is not the case that the patterns of effects differ for healthy versus unhealthy employees, and/or within-person versus environmental mechanisms (2 vs. 1 mechanism supported, respectively).

It is noteworthy that relatively strong improvements in job control only occurred for the job changers, irrespective of their health status. That is, a change of jobs appears to offer good chances to improve job control. In this sense, transferring to a different job may be an effective way to improve one's work situation -- for both the healthy and the unhealthy workers. The fact that both groups seem to profit from a job change was somewhat surprising, because earlier research suggested that unhealthy (i.e., depressive) workers are less able to secure positive outcomes from a job change than others (Taris et al., 1998). It would seem possible, however, that socio-economic circumstances influence the degree to which workers (whether they are healthy or not) can improve their work situation. The present study was conducted when the Dutch economy was still booming, thus offering job seekers good opportunities to find better jobs. However, this may be different in times of economic hardship.

Practical implications. The findings of our study show that there is no single mechanism that accounts for the effects of health on work characteristics. They suggest,

therefore, that the relationship between health and work does not hold for everyone in the same way (cf. Fletcher, 2003). As Semmer (2003, 83) pointed out: "People differ in the probability of *encounting stressors*, depending on their social environment but also on their own behaviour, as some stressors may be self-created". From a practical point of view, our results therefore show that there is no general explanation that can be applied to every worker. Another finding that will interest employers and organisational psychologists alike is that our results showed that finding new employment can result in higher levels of job control for both healthy and unhealthy workers.

Implications for future research. From a theoretical point of view, our results emphasize the benefits of including reversed effects in conceptualizing the relationships between work and (mental) health. In line with earlier longitudinal research, our results show that worklife is more dynamic than most work stress models convey; work not only has an impact on health, but health also has an impact of health on work. This reversed effect should be included in work stress models like the Demand-Control-(Support) model. Karasek and Theorell (1990, p. 9) acknowledged this limitation of their model and stated that their model should not only account for objective work characteristics, but also for perceptions of employees. They formulated a dynamic, integrated environment and person-based version of the Demand-Control model. Our results show that this dynamic model suits the etiology of work stress better than the original Demand-Control-(Support) model; that only emphasized the "objective" work environment.

Acknowledging the existence of reversed effects is not enough. We also need to *understand* these effects. This study is one of the first longitudinal studies theorizing about the mechanisms that account for reversed effects of (mental) health on work, and it distinguished four mechanisms that may explain reversed effects. Indeed, we believe that the main contribution of our study lies in the fact that it proposes (a) a conceptual framework for analysing the effects of health on work characteristics, and (b) methods of testing the mechanisms distinguished within this framework. Our study shows that further research on reversed causality is needed. In this sense ,we hope that our study will inspire new longitudinal research on the causal mechanisms underlying the effects of health on work.

References

Bakker, A.B., Schaufeli, W.B., Sixma, H.J., Bosveld, W., & Dierendonck, D. van (2000). Patient demands, lack of reciprocity and burnout: A five-year longitudinal study among general practitioners. *Journal of Organizational Behavior, 21*, 425-441.

Bollen, K.A. (1989). *Structural equation modelling with latent variables*. New York: Wiley.

Byrne, B.M. (2002). *Structural equation modeling with AMOS*. Mahwah, NJ: Lawrence Erlbaum.

Brief, A. P., Burke, M. J., George, J. M., Robinson, B, & Webster, J. (1988). Should negative affectivity remain an unmeasured variable in the study of job stress? *Journal of Applied Psychology, 73*, 193-198.

Dormann, C., & Zapf, D. (2002). Social stressors at work, irritation, and depressive symptoms: Accounting for unmeasured third variables in a multi-wave study. *Journal of Occupational and Organizational Psychology, 75*, 33-58.

Ettner, S.L., & Gryzwacz, J.G. (2001). Workers'perceptions of how jobs affect health: A social ecological perspective. *Journal of Occupational Health Psychology, 6*, 101-113.

Frese, M. (1985). Stress at work and psychosomatic complaints: A causal interpretation. *Journal of Applied Psychology, 70*, 314-328.

Frese, M., & Zapf, D (1988). Methodological issues in the study of work stress: Objective vs subjective measurement of work stress and the question of longitudinal studies. In C.L. Cooper & R. Payne (Eds.), *Causes, coping and consequences of stress at work* (pp. 375-411). Chichester (UK): John Wiley & Sons Ltd.

Festinger, L. (1957). *A theory of cognitive dissonance.* Evanston, IL: Row, Peterson.

Fletcher, B.C. (2003). A fit approach to work stress and health. In M. J. Schrabracq, J.A.M. Winnubst & C.L. Cooper (Eds.), *The handbook of work & health psychology* (pp. 549-568). John Wiley & Sons Ltd, Chichester, United Kingdom.

Ganster, D.C., & Schaubroeck, J. (1991). Work stress and employee health. *Journal of Management, 17*, 235-271.

Garst, H., Frese, M., & Molenaar, P.C.M. (2000). The temporal factor of change in stressor-strain relationships: A growth curve model on a longitudinal study in East Germany. *Journal of Applied Psychology, 85*, 417-438.

Glickman, L., Tanaka, J. S. & Chan, E. (1991). Life events, chronic strain, and psychological distress: Longitudinal causal models. *Journal of Community Psychology, 19*, 283-305.

Hurrell, J.J., Nelson, D.L., & Simmons, B.L. (1998). Measuring job stressors and strains: Where we are, and where we need to go. *Journal of Occupational Health Psychology, 3*, 4, 368-389.

James, R.J., & Tetrick, L.E. (1986). Confirmatory analytic tests of three causal models relating job perceptions to job satisfaction. *Journal of Applied Psychology, 71,* 77-82.

Johnson, J.V., & Hall, E.M. (1988). Job strain, work place social support, and cardiovascular disease: A cross-sectional study of a random sample of the Swedish working population. *American Journal of Public Health, 78,* 1336-1342.

Jonge, J. de, & Kompier, M.A.J.(1997). A critical examination of the Demand-Control-Support Model from a work psychological perspective. *International Journal of Stress Management, 4*, 235-258.

Jonge, J. de, Dormann, C., Janssen, P.P.M., Dollard, M.F., Landeweerd, J.A., & Nijhuis, F.J.N. (2001). Testing reciprocal relationships between job characteristics and psychological well-being: A cross-lagged structural equation model. *Journal of Occupational and Organizational Psychology, 74,* 29-46.

Jöreskog, K.G., & Sörbom, D. (1993). *Lisrel-8 (user's manual).* Chicago: Scientific Software.

Kalleberg, A. L., & Mastekaasa, A. (2001). Satisfied movers, committed stayers. The impact of job mobility on work attitudes in Norway. *Work and Occupations, 28*, 183-209.

Karasek, R.A. (1985). *Job Content Instrument: Questionnaire and user's guide*. Los Angeles: Department of Industrial and Systems Engineering, University of Southern California.

Karasek, R. and T. Theorell (1990). *Healthy work stress, productivity, and the reconstruction of working life*. New York, N.Y., Basic Books.

Karasek, R., Brisson, C., Kawakami, N., Houtman, I., Bongers, P., & Amick, B. (1998). The Job Content Questionnaire: An instrument for internationally comparative assessments of psychosocial job characteristics. *Journal of Occupational Health Psychology, 3*, 322-355.

Kenny, D. (1979). *Correlation and causality*. New York, John Wiley & Sons.

Kohn, M. L., & Schooler, C. (1982). Job conditions and personality: a longitudinal assessment of their reciprocal effects. *American Journal of Sociology, 87*, 1257-1286.

Kristensen, T.S. (1996). Job stress and cardiovascular disease: A theoretical critical review. *Journal of Occupational Health Psychology, 3,* 246-260.

Lange, A.H. de, Taris, T.W., Kompier, M.A.J., Houtman, I.L.D., & Bongers, P.M. (2002). The effects of stable and changing demand-control histories on worker health:

Results of the longitudinal SMASH study. *Scandinavian Journal of Work, Environment and Health, 28*, 94-108.

Lange, A.H., de, Taris, T.W., Kompier, M.A.J., Houtman, I. L. D., & Bongers, P. M. (2003a). "The Very Best of the Millennium": Longitudinal Research and the Demand-Control-(Support) model. *Journal of Occupational Health Psychology, 8*, 282-305.

Lange, A.H., de, Taris, T.W., Kompier, M.A.J., Houtman, I. L. D., & Bongers, P. M. (2004). The relationships between work characteristics and mental health: Examining normal, reversed, and reciprocal relationships in a 4-wave study. *Work & Stress, 18*, 149-166.

Leiter, M.P., & Durup, M.J. (1996). Work, home and in-between: A longitudinal study of spillover. *Journal of Applied Behavioral Science, 32*, 29-47.

Marcelissen, F.H.G., Winnubst, J.A.M., Buunk, B., & Wolff, C. J. de (1988). Social support and occupational stress: A causal analysis. *Social Science and Medicine, 26*, 365-373.

Marmot, M. G., Madge, N (1987). An epidemiological perspective on stress and health. In. S.V. Kasl, C. L. Cooper (Eds.). *Research methods in stress and health psychology* (pp. 3-26).. New York, John Wiley & Sons Ltd.

Mills, L. B., & Huebner, E.S. (1998). A prospective study of personality characteristics, occupational stressors, and burnout among school psychology practitioners. *Journal of School Psychology, 36*, 103-120.

Moyle, P. (1998). Longitudinal influences of managerial support on employee well-being. *Work & Stress, 12*, 29-49.

Prosser, D. Johnson, S., & Kuipers, E. (1997). Perceived sources of work stress and satisfaction among hospital and community mental health staff, and their relation to mental health, burnout, and job satisfaction. *Journal of Psychomatic Research, 43*, 51-59.

Radloff, L.S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385-401.

Rogosa, D. (1980). A critique of cross-lagged correlation. *Psychological Bulletin, 88*, 245-258.

Schnall, P.L., Landsbergis, P.A., & Baker, D. (1994). Job strain and cardiovascular disease. *Annual Review of Public Health, 15,* 381-411.

Semmer, N. K. (2003). Individual differences, Work, stress and health. In M.J. Schrabracq, J. A. M., Winnubst & C. L. Cooper (Eds.). *The handbook of work & health psychology* (pp. 83-120). John Wiley &Sons Ltd, England.

Spector, P. E., Zapf, D., Chen, P.Y., & Frese, M. (2000). Why negative affectivity should not be controlled in job stress: don't throw out the baby with the bath water. *Journal of Organizational Behavior, 21*, 97-95.

Taris, T.W. (1999). The mutual effects between job resources and mental health: A prospective study among Dutch youth. *Genetic, Social, and General Psychology Monographs, 125*, 433-450.

Taris, T.W. (2000). *A primer in longitudinal data analysis.* Londen: Sage.

Taris, T.W., Bok, I.A., & Caljé, D.G. (1998). On the relation between job characteristics and depression: A longitudinal study. *International Journal of Stress Management, 5,* 157-167.

Taris, T., & Kompier, M. (2003). Challenges of longitudinal designs in occupational health psychology. *Scandinavian Journal of Work, Environment and Health, 29,* 1-4.

Tennant, C. (2001). Work-related stress and depressive disorders. *Journal of Psychosomatic Research,* 51, 697-704.

Van Horn, J. E., Taris, T. W., Schaufeli, W. B., Schreurs, P. J. G. (2004). The structure of occupational well-being: A study among Dutch teachers. *Journal of Occupational and Organizational Psychology, 77*, 365-375.

Van der Velde, M.E.G., & Feij J.A. (1995). Change of work perceptions and work outcomes as a result of voluntary and involuntary job change. *Journal of Occupational and Organizational Psychology, 68*, 273-290.

Warr, P. B. (1987). *Work, unemployment, and mental health*. Oxford: Oxford University Press.

Warr, P. B. (1994). A conceptual framework for the study of work and mental health. *Work & Stress*, 8, 84-97.

Williams, L.J., & Podsakoff, P.M. (1989). Longitudinal field methods for studying reciprocal relationships in organizational behavior research: Toward improved causal analysis. *Research in Organizational Behavior, 11,* 247-292.

Zapf, D., Dormann, C., & Frese, M. (1996). Longitudinal studies in organizational stress research: A review of the literature with reference to methodological issues. *Journal of Occupational Health Psychology, 1,* 145-169.

6

Discussion

6.1 Introduction

The aim of this thesis was to examine the possible causal relationships between psychosocial work characteristics (demands, control and social support of supervisors) and various mental health indicators. In this final chapter we summarize our findings (section 6.2 and Table 6.1), discuss important methodological assets as well as limitations of our research (6.3), address the theoretical implications of our results and formulate recommendations for future research examining the relation between work and mental health (section 6.4 and Table 6.2). We conclude with a discussion of the practical implications of our findings (6.5).

6.2 Summary of main findings

In Chapter 1, we distinguished among five unresolved issues regarding the possible cross-lagged relation between work characteristics and mental health. We did not know: i) whether earlier high-quality longitudinal research found consistent cross-lagged relations between the DC/S dimensions and mental health, ii) which type(s) of causal relation(s) existed between the DC/S dimensions and mental health (normal, reversed or reciprocal?), iii) which time lag(s) was (were) best suited for examining the cross-lagged relations between the DC/S dimensions and mental health, iv) whether duration of exposure could account for normal lagged relations, and v) which mechanism(s) could account for possible reversed lagged relations. We addressed these issues by a) systematically reviewing the methodologically best longitudinal studies examining the DC/S model, b) examining the relation between work and mental health within the framework of the Dutch 4-wave SMASH study, and c) elaborating on the possible mechanisms that may account for normal as well as reversed cross-lagged relations. These issues resulted in five research questions that were dealt with in Chapters 2-5 of this thesis. Below we briefly summarize the results relevant to each research question. Table 6.1 presents a short summary of the results per research question.

Table 6.1

Unresolved issues, associated research questions and results of this thesis

Unresolved issues earlier research	Research questions	Chapter	Results
1 What are the results of (high-quality) longitudinal research?	*Question 1A*: How many previous longitudinal studies examining the DC/S model meet five important methodological criteria and can therefore be labelled as *high-quality* studies?	Chapter 2	-19 studies (42%), of which -12 (63%) included mental health indicators
	Question 1B: What are the results of these high-quality longitudinal studies as regards the propositions advanced in the DC/S model? Do these high-quality studies provide evidence for normal (instead of reversed or reciprocal) causal relationships between Time 1 demands, control, or social support and Time 2 health outcomes?		-Modest support for strain hypothesis; -16 of 19 studies (84%) provided support for normal causal effects of one or more of DC/S dimensions; -Only 2 high-quality studies examined reversed or reciprocal causation
2 Three types of causation in the relation between work and mental health?	*Question 2:* Which causal relationship(s) exist(s) between the DCS measures and mental health?	Chapter 3	-Reciprocal causal relations between DCS measures and mental health outcomes -Normal causal relation dominant
3 Which length of Time lag(s) is (are) correct?	*Question 3*: Which time lag shows the strongest results for demonstrating the relationship between the DCS dimensions and mental health across time?	Chapter 3	-1 year time lag yields best effects

-Table 6.1 continued-

Unresolved issues earlier research	Research questions	Chapter	Results
4 Can exposure history account for normal cross-lagged effects?	*Question 4A*: Are Karasek's predictions for the differences in strain between the four different job types (high strain, low strain, active and passive work) supported for groups with stable exposure to particular levels of demands and control?	Chapter 4	-Only support for strain hypothesis for stable exposure groups and mental health measures
	Question 4B: Do positive (negative) changes in exposure to demands and control result in decreased (increased) strain levels across time, in agreement with the predictions of the demand-control model?		-Mixed results for changing DCH's (only support for negative change groups of low strain to high strain jobs)
	Question 4C: Can change in reported exposure to demands and control be linked to "objective" change in the work environment?		-Yes, significant associations between changes in DC-histories and self-reported job changes
5 Which mechanisms account for reversed cross-lagged effects?	*Question 5*: Which environmental or perceptual change mechanism(s) can explain the reversed lagged effect of mental health on the DCS dimensions?	Chapter 2,5	-Positive effects of mental health on job demands within stayers' groups can be interpreted as support for rosy perception mechanism -Positive effects of mental health on job control within job changers' groups can be interpreted as support for upward selection mechanism -Negative effects of mental health on social support of supervisor within stayers' groups can be interpreted as support for gloomy perception mechanism

Question 1a,b: What are the results of previous high-quality longitudinal research examining the DC/S model? Chapter 2 presented the results of a systematic review of 45 longitudinal studies examining the DC/S model. The application of five important methodological criteria (adequate study design, presence of an argumentation for the time lags used, good quality measures, adequate method of analysis, and presence of a nonresponse analysis, respectively) showed that 19 (42%) of these could be regarded as methodologically *high-quality* studies.

Subsequently, the results of the 19 high-quality studies were reviewed regarding the propositions advanced in the strain hypothesis of the DC/S model. This review provided only *modest support* for the strain hypothesis of the DC/S model. Eight of the 19 high-quality studies (42%) demonstrated the expected combination of additive or multiplicative effects of the DC/S dimensions, usually in the form of additive effects only. The fact that the high-quality longitudinal studies reported few interaction effects is consistent with previous (mainly cross-sectional) findings that multiplicative effects are rare (Kasl, 1996; Kristensen, 1995; Theorell & Karasek, 1996).

Question 2: Which causal relationship(s) exist(s) between the DCS measures and mental health? Few of the high-quality studies reviewed in Chapter 2 examined potential reversed or reciprocal causal relations (with the exception of Carayon, 1992, 1993). As a consequence, it was impossible to interpret the significant cross-lagged relations as exclusively reflecting normal causal effects; other types of causal relationships have largely been ignored. Other reviews also pointed to the paucity of longitudinal research examining reversed or reciprocal causal relations (cf. van der Doef & Maes, 1999; James & James, 1989; Tennant, 2001; Zapf et al., 1996). We therefore set out to examine, within the 4-wave SMASH study, how the associations between the DCS dimensions and mental health should best be conceptualised: as normal, reversed or as reciprocal cross-lagged relations. We postulated and compared the fit of different structural equation models reflecting the different types of causation, and found consistent evidence for *reciprocal cross-lagged relations* between the DCS dimensions and indicators of mental health. The normal cross-lagged effects were *causally predominant*.

Question 3: Which length of Time lag(s) shows the strongest results? In exploring the dynamic interplay between work and mental health it is important to discuss the appropriate

time interval to demonstrate cross-lagged effects. Chapter 2 showed that few longitudinal studies provide a rationale for using a particular time lag to measure the impact of work on (mental) health. Only seven of the 45 longitudinal studies (16%) presented a clear rationale for the time lag that was used. Many different theoretical time models may apply to a particular cross-lagged relation and few longitudinal studies tested these different time models (Frese & Zapf, 1988). Given the absence of strong evidence for the adequacy of a particular time lag, it is not surprising that many researchers fail to provide a clear rationale for the time lags used in their studies. One way to provide more information about the required length of a time lag is to examine as many different causal lags as possible (Kessler & Greenberg, 1981; Rogosa, 1979). The 4-wave SMASH study gave us the opportunity to examine three different lengths of time lags and combinations of these, namely 1-, 2- , and 3-year time lags. We therefore examined which length of time lag(s) showed the strongest results for demonstrating a cross-lagged relation between work and mental health.

In line with Dormann et al. (1999; 2002), we expected that the 1-year time lag (i.e., the smallest time lag possible in the SMASH study) would be the most appropriate for finding a significant relationship between the DCS dimensions and mental health. Moreover, our review of previous longitudinal research (see Chapter 2) also revealed significant additive effects of the DC/S dimensions on psychological well-being, burnout and anxiety across time lags of one year. The best model fit across all 4 waves was indeed found for a *1-year time lag*.

Question 4a: Is Karasek's strain hypothesis supported for groups with stable exposure histories? Chapter 2 and 3 present evidence for cross-lagged effects of the DCS dimensions on mental health, but we also wanted to examine and try to *understand* these effects in more detail. The question was whether the normal cross-lagged effects of work characteristics on mental health could be explained by the duration of exposure to particular combinations of demands and control. Other researchers (cf. Karasek & Theorell, 1990) already pointed to this mechanism, but the studies examining the impact of duration of exposure remained "sketchy" (Beehr, 1998, p. 19). A classification of theoretically meaningful Demand-Control-histories (DCH's or "exposure profiles") was developed. For each of these DCH's, hypotheses were formulated concerning their across-time

development in terms of (mental) health outcomes. In line with our expectations, the highest levels of mental health problems (depression and job dissatisfaction) were found for incumbents of stable high strain jobs, whereas relatively few mental health problems were reported by employees working in stable low strain jobs across time. Further, the employees in the stable high strain jobs (with high demands and low control) reported significant increases in mental health problems across time.

Question 4b: Is Karasek's strain hypothesis supported for groups with changing exposure histories? We further examined whether the across-time changes in the strain outcomes reported by those experiencing a non-stable DCH were in line with the strain hypothesis of the DC model. The results showed that changes from Time 1 low strain to later high strain work, and from Time 1 active/passive work to later high strain work were indeed associated with elevated levels of depression and job dissatisfaction. However, the corresponding positive change (i.e., from the Time 1 high strain condition to the later no-high strain condition) was not significant for the outcome variable depression and showed mixed results for job dissatisfaction (see Chapter 4).

Question 4c: Can change in reported exposure to demands and control be linked to "objective" change in the work environment? Since Karasek's (1979) DC model is basically an environmental model, we considered it important to check whether subjectively reported changes in work characteristics could be linked to "objective" [6] changes in the work environment. Chapter 4 revealed significant associations between changes in DC-histories (i.e., changes in self-reported demands and control) and self-reported job changes. Further, we found that employees who reported negative changes in self-reported job conditions were more likely to have experienced this change as stressful, compared to workers with positive DC-histories (see Section 6.4). These findings provide converging evidence for the assumption that changes in subjectively experienced well-being can be traced back to corresponding changes in the work environment.

Question 5: Which environmental or perceptual change mechanism(s) can explain the reversed lagged effect of mental health on the DCS dimensions? This thesis revealed

[6] "objective" in the sense that reporting these changes requires little cognitive processing (Frese & Zapf, 1988).

consistent (albeit weak) *reversed* lagged effects of mental health on work (see Chapter 3 and 5) and we therefore wanted to explore possible mechanisms to explain these effects. In Chapter 5 we proposed four mechanisms for possible reversed effects of mental health (measured in terms of 'depressive mood') that reflect perceptual versus environmental changes: (i) rosy perception mechanism, ii) gloomy perception mechanism, iii) upward selection mechanism, and iv) drift mechanism. Chapter 5 revealed results in line with the *rosy perception* mechanism (positive effects from mental health on job demands), the *upward selection* mechanism (positive effects from mental health on job control), and the *gloomy perception* mechanism (negative effects from mental health on supervisor social support). No support was found for the drift mechanism.

6.3 Assets and limitations

It is important to address the methodological assets as well as the limitations of this thesis in relation to the results found. We will first discuss what we believe to be the stronger points of this thesis.

6.3.1 Strong points of this thesis

Methodological quality of study. In chapter 2 we developed a system to rate the methodological quality of the longitudinal studies selected for our review (see Table 2.1). We can also apply these criteria to our own studies to determine their methodological quality. The studies reported in this thesis are based on a complete 4-wave panel study and we would therefore obtain 4 stars (*very good*) on the criterion *design*. Furthermore, we would have achieved 2 stars (*sufficient*; Chapter 4 and 5) to 4 stars (Chapter 3; explicitly testing the length of time lags) on the criterion *time lags* as we did not always explicitly present arguments for choosing a 1-year time lag. On the criterion *measures*, we would have scored 3 stars (*good*; Chapter 3 and 5) as we base our results mainly on self-report data (see limitations below). When including the (non-significant) results of sickness absence in Chapter 4 we might have obtained 4 stars (*very good*). In this thesis we mostly used structural equation modelling or repeated measurements ANOVA as the *method of analysis*, which are adequate methods for analysing different types of causal relationships and across-time differences among groups (obtaining 3 stars for "method of analysis").

Finally, as the baseline response was relatively high (84%), we only examined the follow-up responses in our studies (obtaining 2 stars, *sufficient* for the criterion "nonresponse analyses"). In other words, the methodological quality of our research can be regarded as a strong asset. Especially our 4-wave panel design was a valuable tool in examining the nature and direction of the cross-lagged relations between the DCS dimensions and mental health.

Theoretically meaningful subgroup analyses. Since different subgroups may follow different time models (Frese & Zapf, 1988; Kasl & Jones, 2003), we distinguished and compared theoretically meaningful subgroups across time. Chapter 4 and 5 were based on subgroups with and without meaningful changes in exposure status, namely job changers versus stayers. According to Kasl and Jones (2003), especially the baseline prechange data and cross-lagged changes reported by these job changers versus stayers (two conditions in a 'natural experiment') can provide more information about cause-and-effect relationships compared to analyses based on groups without these theoretically meaningful changes in exposure to work. Our results showed that certain subgroups of workers (such as the stable high strain group) report significant changes in mental health across time, whereas other subgroups report no significant changes (like the group working in a stable active job). At the aggregate level these specific changes would have cancelled each other out and would have remained undetected (Taris & Kompier, 2003).

Kasl and Jones (2003) point out that theoretically meaningful subgroup analyses are relatively rare in occupational health psychology. Our thesis showed that this approach to analysing intra- and intergroup across-time development can provide relevant insights into the cross-lagged relation between work and mental health (cf. Sections 6.4 and 6.5). We therefore reckon the subgroup analyses presented in this thesis among its stronger assets.

6.3.2 Limitations of this thesis

Although our studies would thus presumably be evaluated as high-quality longitudinal research, there were also limitations in testing the cross-lagged relations between the DC/S dimensions and mental health. These limitations refer to i) selective response, ii) the collection of mainly self-reported survey data, iii) small effect sizes, and iv) the presence of potential confounders.

Selective response. For the SMASH study, respondents with relatively stable work environments were selected, implying a restriction of range in the work characteristics. For example, one of the criteria for inclusion in the study was that the companies had a relatively low turnover rate and only respondents were selected who had been working for at least one year with a permanent contract for at least 20 hours per week (Hoogendoorn, 2001). In addition, our nonresponse analysis for the follow-up waves showed that drop-outs reported relatively more strain complaints on baseline compared to the response group (implying attrition bias). Consequently, we examined relatively healthy workers with relatively stable work environments. As a result of this restriction-of-range, we may have underestimated the true causal effects between the DC/S dimensions and mental health.

In order to answer our research questions, different subgroups of respondents were selected. These selections were based on theoretical arguments (for example, on several occasions we restricted our analysis to respondents working in stable high strain jobs). Nonetheless, some subgroups were based on relatively small numbers of employees (leading to low statistical power). For example, in Chapter 3 the results were based on 668 employees who reported no job changes across time, whereas Chapter 5 presented the results for 1006 job changers and 210 stayers. Since we found similar results across the different studies (with varying numbers of respondents included) we believe that the presented results were not severely affected by these differences in statistical power.

Self-report measures for (in)dependent variables. Another limitation of our results is that they are mainly based on survey data (with the exception of sickness absence data analysed in Chapter 4). Survey data are appropriate for assessing the prevalence of exposure to work characteristics when the items are formulated in a neutral or factual manner (Semmer et al., 2004). The response categories of our work characteristics were worded as opinions or attitudes (varying from 1=”strongly agree” to 4=”strongly disagree”), which may therefore have resulted in more error variance compared to response categories measured in more neutral terms (such as the response categories we used to measure Depression: 1 = "hardly ever or never", 3 = "much or most of the time"; Kristensen, 1996).

Yet, results from self-report data are better than usually expected (Semmer et al., 2004). In several empirical studies, Semmer et al. (2004) showed that self-report data

contain unique true (as well as error or method) variance compared to other types of data collection like observational or physiological data. However, the problem of using only survey data is the risk of self-report bias, e.g., due to personality traits such as negative affectivity (Kasl & Jones, 2003). It is often recommended to combine self-report measures with "objective" measures in order to mitigate the effects of methodological and/or conceptual overlap between the measured variables (Kasl, 1978; Kristensen, 1996; Semmer et al., 2004). We therefore paid some attention to common method variance as a potentially confounding factor in our studies. In Chapter 5 we controlled for the possible bias of negative affectivity by including this factor as an additional explanatory variable in our analysis. This analysis revealed that the effects of the other variables remained virtually unchanged, suggesting that negative affectivity did not bias our findings substantially; the reversed effects of mental health were still significant after controlling for NA. Furthermore, Chapter 4 revealed that major changes in self-reported changes in job demands and job control were associated with actual job changes. We therefore believe that our results were not severely biased due to common method variance. Nonetheless, to fully demonstrate causal relationships it is necessary to also include other (than self-report) types of measurements. For example, to provide biological plausibility for work-health aetiology, researchers should also include physiological strain measures (Belkić et al., 2004; Kompier & Taris, 2004; Semmer et al., 2004).

Small effect sizes: statistical significance versus practical relevance. The studies in this thesis report relatively low standardised regression coefficients. Hence, relatively little variance in the outcomes is accounted for, which may suggest that the practical relevance of our findings is quite limited. According to Semmer et al. (1996), small standardised effects are to be expected in longitudinal research, as there is an upper limit of 15 to 20 percent variance in strain that can be explained by job stressors. A large part of the variance in strain measured on Time 2 will be explained by the same variable measured on baseline or Time 1 (e.g., auto-correlations of r =.70 indicate that both measures share 49% of their variance). It is important to note that the cross-lagged effects of, for instance, job demands on depressive mood found in this thesis refer to predicting *change*s in depressive mood from Time 1 to Time 2 (i.e., partialling out the Time 1-Time 2 stability effects). By definition these effects will be small, as many phenomena will be relatively stable across

the 1-year time interval employed in this study. The small standardised effects may also result from measurement error, restriction in range (e.g., due to the inclusion of healthy workers only), the complexity of different kinds of causal relations across time (e.g, among different subgroups), the influence of moderator variables that were not accounted for, and the multi-causal nature of strain outcomes. For example, mental health outcomes may also be affected by non-work stressors (Frese & Zapf, 1988). Including only work related factors may therefore have resulted in low levels of explained variance.

Statistical significance does not by definition imply practical relevance. We should therefore consider the practical relevance of these small statistical effects in longitudinal research. Not all our results can easily be translated in practical implications, but we regard the results found in our subgroup analyses (especially in Chapter 4 and 5) of interest to the practical field. These analyses revealed larger effect sizes for particular subgroups. For example, significant cumulative lagged effects were found for stable subgroups working in high strain work environments and for subgroups that transferred from a "no-high strain" job (like an active or passive job) to a high strain work environment. Just like drops of water may dent a stone across time, we believe that these cumulative effects found in our research can accumulate, possibly resulting into severe health complaints across time. We therefore believe these findings to be of scientific as well as practical relevance (see also practical implications in section 6.5).

Unmeasured variables or potential confounders. In examining the causal nature of the cross-lagged relation between the DCS dimensions and mental health, we found that various unmeasured variables (potential confounders) may have been of importance in assessing these causal relations. For example, to draw more definite conclusions as to the different perceptual and environmental reversed causation mechanisms (Chapter 5), we would need more information about the type of job change reported than was available in our data set. Did we actually examine self-initiated job changes (e.g., reflecting a positive coping behaviour) or were the job changes initiated by others (e.g., reflecting more involuntary actions)? Earlier research (cf. Kalleberg & Mastekaasa, 2001; van der Velde & Feij, 1995) has shown that a self-initiated job change is often associated with positive work outcomes, while an employer-initiated job change is more often associated with negative outcomes. It would seem possible that the positive outcomes reported by our job changers

can be attributed to the fact that we merely examined voluntary job changes. More qualitative and objective information on the nature of these job changes is clearly needed to further understand these reversed effects.

Furthermore, in Chapter 2 we were unable to evaluate the impact of the different types of confounders that were included in the longitudinal studies examining the DC/S model. Based on earlier research (Karasek & Theorell, 1990), we controlled for the potential confounders age, gender, education and years of experience. Whether a researcher should control for a particular variable depends strongly of the process under study -- but as the precise nature of this process is often largely unknown, it is also unknown *which* variables should be controlled for. Similarly, Tennant (2001) showed in his review that, in examining depressive disorders, researchers often control for i) specific stressful events in the workplace, ii) hours worked, iii) job involvement, iv) job controllability, v) personality, and vi) social support. The reviewed studies showed mixed results for these different covariates and it was not always clear whether the variables were independent predictors of depression or moderators in the relation between work and depression (Tennant, 2001). More research based on clever thinking is clearly needed to understand *whether* and *why* one should control for a particular confounder in relation to the nature of the process under study.

6.4 Theoretical implications and recommendations for future research

In spite of the aforementioned limitations, we believe that the results presented in this thesis have theoretical implications that lead to new recommendations for future research in this field. These implications and recommendations are discussed in relation to the five research issues dealt with in this thesis (see Table 6.1). We conclude with a relatively new issue.

6.4.1 Issue 1: What are the results of (high-quality) longitudinal research?

Methodological quality of studies. Chapter 2 showed that 42% of the selected longitudinal studies could be regarded as high-quality research. This small percentage of high-quality studies implies that longitudinal research should pay more attention to quality aspects of study design (Zapf et al., 1996); simply adding a follow-up wave to a cross-

sectional study does not necessarily improve study quality. Preferably, future research examining the relation between psychosocial work characteristics and mental health should employ complete panel designs with multiple waves to better examine the aetiology of the cross-lagged relation between work and (mental) health (Taris & Kompier, 2003). Moreover, these studies should more explicitly address the time lags used and possible selectivity of the (pre-) baseline and follow-up responses. For example, researchers should try to collect information about the psychosocial work exposure history and the pre-baseline health status. By determining the exposure status of respondents before Time 1, researchers may prevent selective baseline response (Belkić et al., 2004). Such information can also help in determining the length of time lag(s) needed to demonstrate effects (see issue 3 below).

Modest support for the strain hypothesis. Chapter 2 also revealed that the 19 high-quality studies provided only modest longitudinal support for the DC/S model. These results do *not* provide stronger support for the strain hypothesis of the DC/S model than the mixture of excellent and not-so-excellent studies included in previous reviews (e.g. de Jonge & Kompier, 1997; van der Doef & Maes et al., 1998; 1999). The proportion of studies supporting the strain hypothesis, thus, did not differ as a function of study quality. In this respect, the present review of high-quality research would not seem to add much to what is already known. However, our review did enhance current knowledge regarding the longitudinal relations between the DC/S dimensions and strain outcomes, as we did find consistent *cross-lagged* (additive) relations between (one or more of) Time 1 DCS dimensions and Time 2 indicators of mental health (16 of the 19 high-quality studies; 84%). The theoretical implication of these findings may be that not so much the specific *combinations* of, but rather the *separate main* effects of job demands, job control and social support are important in predicting (mental) health complaints.

6.4.2 Issue 2: Three types of causation in the relation between work and mental health?

Reciprocal causal relations. Only two high-quality studies (Carayon, 1992; 1993) examined reversed or reciprocal causal relations between the DC/S dimensions and (mental) health outcomes. Thus, little was known about the presence and impact of these

types of causal relationships. We examined this issue further and found consistent reciprocal cross-lagged relations between the DCS dimensions and mental health across all 4 waves. The effects of work characteristics on mental health were causally predominant. This result underscores the importance of job demands, job control and social support of supervisors in the development of mental health status across time. Moreover, it supports the causal ordering of these work characteristics in the Demand-Control-Support model (Karasek & Theorell, 1990). Although this normal causal process seems to be the most prominent, our results confirmed earlier findings (e.g., de Jonge et al., 2001; Leiter & Durup, 1996) that health influences workers' job conditions as well.

These results suggest the presence of a vicious circle that seems to start with the (causally dominant) effects of work characteristics on health. For example, a worker who received more job control on Time 1 may feel more satisfied about his or her job after a time lag of 1 year and, subsequently, report more job control (as a result of a more positive perception or an actual job change) on Time 3 etc. Although this assumption should be validated in other longitudinal research, our consistent reciprocal results do imply that the one-directional view in the DC/S model and other theoretical approaches in the occupational health field is too one-sided. Karasek and Theorell (1990, p. 99) did propose a more dynamic version of the Demand-Control model, in which they hypothesize that i) stress inhibits learning; and ii) learning, in the long term, can inhibit stress (Taris & Feij, 2005, for an empirical test of this reasoning). Other theoretical approaches recognize related aspects like personal moderator variables which influence the relation between work characteristics and health outcomes (i.e., 'critical coping' in the Effort-Reward Imbalance model (Siegrist, 1998), or 'individual moderator variables' in the Job Characteristics Model (Hackman & Oldham, 1976)). The Michigan Organizational Stress model (Caplan, 1975) even recognizes that personal characteristics may influence how the *objective* work environment (through perception and interpretation) will be translated into a *psychological* work environment. Nevertheless, none of these theoretical approaches explicitly addresses or postulates a (potential) feedback loop of mental health on psychosocial work characteristics across time. More theory about reversed causation and graphical presentations of these (potential) feedback loops in current work stress models are clearly needed. Future research should therefore not only examine normal, but also reversed and

reciprocal causal relationships between psychosocial job characteristics and indicators of well-being.

6.4.3 Issue 3: Which length of Time lag(s) is (are) correct?

1-year time lags. Current occupational health research provides us with few clues regarding the time intervals needed to confirm a particular hypothesis like the strain hypothesis of the DC/S model. Karasek and Theorell (1990) suggested that the longer one has been exposed to a high strain job, the more strain complaints he or she will develop (a mechanism labelled as "exposure time effect" by Frese & Zapf, 1988). Frese and Zapf (1988) distinguished a more (abrupt) causal process in which the initial impact of the stressor is the strongest (labelled as "initial time impact"). Chapter 2 showed that, as yet, few longitudinal studies paid attention to these different types of temporal developments. Researchers often wrongly assume a similar time lag for the relations between different independent and dependent variables (cf. Semmer et al., 2004; Chapter 2 of this thesis).

This thesis provided new clues regarding the appropriate length of time lag for a particular relation. First, our systematic review (chapter 2) revealed significant 1-year additive effects of the psychosocial work characteristics on mental health, whereas less consistent results were found for other types of outcomes (like cardiovascular disease). In line with these results, our empirical analyses in Chapter 3 revealed consistent reciprocal cross-lagged effects across three different 1-year time lags (1994-1995, 1995-1996, 1996-1997). This result indicates that the reciprocal relation between the DC/S dimensions and mental health is not a sudden but rather a more continuous process (in line with the "exposure time effect"; Frese & Zapf, 1988). Hence, it appears that 1-year time lags are appropriate for finding significant cross-lagged effects of the DCS dimensions on mental health.

Nevertheless, we cannot exclude the possibility that smaller time lags than 1 year are just as (or even more) appropriate for testing the relation between work and mental health. Recently, Semmer et al. (2004) showed (mostly) synchronous effects of work characteristics on psychosomatic complaints, whereas (mostly 1-year) lagged effects were found for the outcome blood pressure. Semmer et al. (2004) concluded that these effects were not simply cross-sectional results and argued that the relatively short-term effects of

work on psychosomatic complaints are in line with the "stress-reaction" model (strain disappears with offset of stressors) of Frese and Zapf (1988). An alternative explanation for these short-term effects (compared to our lagged effects) is that the study was based on a group of young workers who had just entered the workforce and, as a consequence, did not have enough exposure history to present significant lagged effects (see Chapter 4). Our study illustrates that the choice of time lag may depend on the type of outcome and population under study. Our results have also shown that the appropriate length of time lag(s) differs across subgroups. Chapter 4 revealed that employees working in a stable high strain job across a time lag of 1 year showed significant mental health effects, whereas their co-workers who transferred from a high strain to a low strain job did not reveal such significant effects. Kasl and Jones (2003) noted that researchers often examine 'steady-state cohorts' during an arbitrary time period. The problem with this type of research is that the particular time lag used (for example 1 year) may be right for certain subgroups of workers (like the stable high strain workers), whereas it can also be "too early" or "too late" for other subgroups (like certain job changers or young workers who just entered the workforce).

Consequently, (before data collection) researchers should determine what would be the appropriate time model for their research relation based on theoretical arguments or empirical evidence (cf. Frese & Zapf, 1988; Landsbergis & Theorell, 2000; Taris & Kompier, 2003). More specifically, the appropriate length of time lag for the relation between psychosocial work characteristics and mental health depends on the following factors: i) the type of predictor and outcome being measured (as the form of change pattern(s) may differ significantly for distinct behaviours across time; Nesselroade & Baltes, 1979; Frese & Zapf, 1988), ii) (the shape of) the intra- and inter-group across-time development of the relation between the predictor and outcome (as this relation may exhibit nonlinear and nonmonotonic trajectories within different subgroups; Nesselroade & Baltes, 1979), iii) the onset, amount and duration (also pre-baseline) of exposure to the stressors of interest, iv) the (preexisting) vulnerability of the selected population (in terms of physical and mental complaints), and v) other relevant confounders in the relation between work and mental health (like important life-events etc.).

Hence, to further understand the time dynamics of the cross-lagged relation between work and health, researchers should further theorize and test different time intervals across different theoretically meaningful subgroups. Moreover, they should design their studies as complete panel studies with many follow-up measures that are both evenly and unevenly spaced. By using unevenly spaced time lags researchers can explore different effects of stressors over time; whereas with evenly spaced time lags one can control for time-variant effects such as seasonal effects. On the other hand, researchers should also realize that a design with many follow-up measurements might seriously reduce the response group due to 'research-fatigue'. A researcher will therefore have to "give and take" in designing their study. Given the minimum of participants needed to guarantee enough statistical power and the practical restraints of their study, a researcher should aim at including more waves with varying lengths of time lags.

6.4.4 Issue 4: Can exposure history account for normal cross-lagged effects?

Results indicate support for exposure history mechanism. In line with the assumptions of Karasek and Theorell (1990), Chapter 4 showed that stability and change in psychosocial work exposure can account for the development of mental (ill)health across time. For example, we found significant (cumulative) detrimental strain effects of being exposed to a high strain job across 4 waves (in line with the strain hypothesis of the DC/S model). Further, a transfer from a Time 1 no-high strain job (active, passive or low strain work) to a later high-strain job was associated with significant increases in mental health complaints.

On the other hand, a positive change from a Time 1 high strain job to a later no-high strain job was *not* associated with a significant decrease in mental health problems. One possible explanation is that prolonged exposure to a high strain job has affected the workers' capacity to recover from job-related fatigue (similar to the 'accumulation model' suggested by Frese & Zapf, 1988; Kompier, 1988; Meijman & Mulder, 1998; Sluijter et al., 2001). A competing explanation is that in such cases the feelings of exhaustion are mainly caused by other non-work related factors (like a poor marriage) that remained unaffected by the job change. Future research may control for these alternative explanations by including covariates that measure (changes in) life events.

More research into these changing DCH's is needed to understand the mechanisms that may account for the across-time changes, and to provide more information about the time-lag(s) needed to reveal significant effects for the stable versus changing DCH's. We can conclude that the plausibility of cause-and-effect relations in longitudinal research can be further improved by examining and comparing subgroups with different work exposure histories and by including employees with temporal sequence changes (intra- or interoccupational changes; Hamborg, & Greif, 2003; Kasl & Jones, 2003).

6.4.5 Issue 5: Which mechanisms account for reversed cross-lagged effects?

Results indicate support for perceptual as well as environmental change mechanisms. Chapter 5 revealed support for perceptual as well as environmental change mechanisms in explaining the reversed effect of mental health on the DCS dimensions across time. We think that these different reversed effects can be explained by different types of coping behaviour to reduce one's mental health complaints or to retain one's mental health (Folkman & Lazarus, 1980). It is often assumed (Edwards, 1998; Hobfoll, 2001) that workers strive to build, protect and retain their (mental health) resources. An unhealthy worker with active coping skills may be able to transfer to, or look for 'refuge' in, a more favourable work environment ('environmental changes'; Garst et al., 2000). In line with this assumption, De Croon et al. (2004) showed that strain can stimulate inter-occupational turnover (more than intra-occupational turnover). These results are in line with our hypothesized environmental change mechanisms. Reversed effects of mental health resulting in true positive environmental changes can therefore be interpreted as effective coping methods to build or retain one's mental health status.

Our findings also suggest that (environment-based) theories like the DC/S model are constructive in explaining normal causal effects of work, while (intra-person) psychological theories may be more efficient to explain the reversed causal effects of mental health. In other words, 'perceptual' reversed effects may be examined further from a (theoretical) cognitive psychological perspective. Do unhealthy workers colour their perceptions in line with their expectations of the work environment (as a result of a "cognitive dissonance" effect; Festinger, 1957)? According to Hackman (1969), human beings have the tendency to (unintentionally and also intentionally) redefine their work environment according to the

principle of "cognitive economy". Following this principle people use external cues, or even produce new cues, in order to retain emotional and cognitive equilibrium (self-regulation; Hacker, 2003). This line of reasoning may apply to the reversed mental health effects found in this thesis.

This thesis used 'depressive mood' for testing the reversed causation mechanisms, since depressive complaints seem to be a good representative of strain as a chronic affective response (Karasek & Theorell, 1990). Nevertheless, other strain related variables may also be useful for examining potential reversed effects. Such research may reveal to which degree the present results can be generalized to other settings and research variables (Rothman & Greenland, 1998). Future research should aim at further *understanding* these reciprocal effects.

6.4.6 New Issue: Positive indicators of mental health

We wanted to examine the strain hypothesis of the DC/S model in longitudinal perspective and therefore only focused on these work characteristics and indicators of mental health complaints. Similarly, earlier longitudinal research (see Chapter 2; van der Doef & Maes, 1999; Kasl, 1996; Kristensen, 1995) was limited to the strain hypothesis of the DC/S model. Nevertheless, work can also be activating and motivating (Karasek & Theorell, 1990). As yet, few researchers explicitly address the activation hypothesis of the DC/S model (see for exceptions: Holman & Wall, 2002; Taris, Kompier, de Lange, Schaufeli, & Schreurs, 2003; Taris & Kompier, 2004). This would not be so important, were it not that Karasek and Theorell (1990) assume that strain and learning mutually influence each other (in the aforementioned dynamic DC model). For example, it is expected that employees in active jobs will develop new skills that allow them to deal more effectively with the inevitably strain-inducing situations in their jobs. Thus, in order to obtain a fuller understanding of the across time relationships between work characteristics and health, more research on the activation hypothesis would seem desirable.

Finally, Table 6.2 summarizes the main theoretical implications and recommendations of this thesis (see next page).

Table 6.2

Main theoretical implications and recommendations of thesis

Research issues (See Table 6.1)	**Theoretical implications**	**Recommendations**
1 What are the results of (high-quality) longitudinal research?	-Small percentage of longitudinal studies can be regarded as high-quality research	-Future longitudinal research should pay more attention to quality aspects of study
	-Modest support for strain hypothesis: only support for cross-lagged *additive* effects of DC/S dimensions	-More research on separate main effects of DC/S dimensions
2 Three types of causation in the relation between work and mental health?	-Evidence for reciprocal causal relations between work and mental health illustrates that one-directional view of DC/S model is too one-sided -Normal causal effects of work on mental health are dominant	-More theorizing and research on different types of causation in relation between work and mental health
3 Which length of Time lag(s) is (are) correct?	-1-year time lags are appropriate for examining the relation between DCS dimensions and mental health	-Researchers should consider the following factors in determining the length of time lag: i) the type of predictor and outcome being measured; ii) (shape of) the intra- and inter-group across-time development of the relation between the predictor and outcome; iii) the onset, amount and duration (also pre-baseline) of exposure to the stressors of interest; iv) the (preexisting) vulnerability of the selected

Research issues (See Table 6.1)	Theoretical implications	Recommendations
		population; v) other relevant confounders in relation between work and mental health -Preferably, researchers should design complete panel studies with many follow-up measures that are both evenly and unevenly spaced
4 Can exposure history account for normal cross-lagged effects?	-Yes, exposure history can account for normal cross-lagged effects	-More research into stable and changing DC histories
5 Which mechanisms account for reversed cross-lagged effects?	-Environment-based theories like DC/S model can be used to explain normal cross-lagged effects of work, whereas (intra-person) cognitive psychological theories may be used to explain reversed mental health effects	-Future longitudinal research should aim at further understanding reciprocal effects

6.5 Practical implications

We believe that the reciprocal causal relations found in this thesis have the following practical implications for employees, their employers, occupational health services and other professionals working in the occupational health field.

1 Evidence for positive impact of Job (re-)design. The normal cross-lagged effects found in this thesis indicate that work related interventions directed at decreasing job demands, increasing job control and/or social support of supervisors may indeed improve the mental health of workers (cf. Michie and Williams, 2003). More specifically,

decreasing the job demands of workers may result in less symptoms of depressive mood or emotional exhaustion across time, whereas increasing the job control of workers may result in an increased job satisfaction across time. These results are compatible with the Dutch Working Conditions act, which amongst others aims at improving or retaining a healthy psychosocial work environment (Schaufeli & Kompier, 2001).

2 Job (re-)design especially for 'high-risk subgroups'. The results also showed that particular subgroups of workers run a higher risk of developing strain complaints than others. The first subgroup at risk, consists of people who work in a high strain job (with high job demands and low control) over a *prolonged* period of time. Our results revealed that these workers will develop significant more mental health complaints compared to people working in a passive, active or low strain job. The second subgroup at risk, consists of people who transfer (from a no-high strain job) to a high strain job. These job changers will develop significant more mental health complaints compared to workers with other types of job transitions. Employees working in these particular job conditions and their employers should be aware of these health effects of being exposed or transferring to a high strain work environment.

Our results also illustrated that a positive job transition does not always result in short-term improvements of mental health. Chapter 4 showed that the subgroup of workers who transferred from a high strain job to a no-high strain job did not automatically improve their mental health status across time (indicating an 'accumulation effect'; Frese & Zapf, 1988). The effect of having been in a high strain job seems to have a lasting effect on the workers' health, even if the work environment changes positively. Furthermore, mental health problems may also be related to non-work factors not included in this thesis. *Occupational health services* should monitor and help these high-risk subgroups to assure that they retain or improve their mental health.

3 Evidence for reversed effects of mental health. Although the normal cross-lagged effects seem causally dominant, we also found consistent evidence for reversed effects of mental health. Professionals working in the occupational health field should therefore consider this potential feedback loop of mental health. They might monitor whether workers with severe mental health problems (cognitively) "reinterpret" their appraisals of the work environment (Folkman & Lazarus, 1980). If so, employers can use stress

management interventions to increase the coping capacity of these relatively unhealthy employees (Murphy, 2003). An example of a stress management intervention to reduce reversed perceptual effects is a ‘cognitive-behavioural technique’, directed at changing the emotions or behaviours by changing the underlying cognitions (such as a biased perception of the psychosocial work environment; Le Blanc et al., 2000; Kompier, 2003; Van der Klink et al., 2001).

In brief, the results imply that job (re-)design can be a valuable tool in improving the mental health status of workers across time. The results also revealed that certain subgroups run a higher risk of developing mental health complaints than others and the practical field should therefore especially monitor these more vulnerable subgroups of workers. Person-directed interventions may be needed to retain and improve the mental health status of these workers.

References

Beehr, T. (1998). An organizational psychology meta-model of occupational stress. In C.L. Cooper (Ed.), *Theories of organizational stress* (pp. 6-27). New York: Oxford University Press.

Belkić, K., Landsbergis, P.A., Schnall, P.L., & Baker, D. (2004). Is job strain a major source of cardiovascular disease risk? A critical review of the empirical evidence, with a clinical perspective. *Scandinavian Journal of Work, Environment and Health, 30*, 85-128.

Caplan, R., Cobb, S., French, J., & Harrison, R. (1975). *Job demands and worker health: Main effects and occupational differences.* Washington, DC: NIOSH.

Carayon, P. (1992). Longitudinal study of job design and worker strain: Preliminary results. In J. Campbell Quick, L.R. Murphy and J.J. Hurrell (Eds.), *Stress and well-being at work* (pp. 19-32). Washington: APA.

Carayon, P. (1993). A longitudinal test of Karasek's job strain model among office workers. *Work & Stress, 7,* 299-314.

De Croon, E. M., Sluiter, J. K., Blonk, R. W. B., Broersen, J. P. J., & Frings-Dresen, M. H. W. (2004). Stressful work, psychological job strain, and turnover: A 2-year prospective cohort study of truck drivers. *Journal of Applied Psychology, 89*, 442-454.

Daniels, K., & Guppy, A. (1997). Stressors, locus of control and social support as consequences of affective psychological well-being. *Journal of Occupational Health Psychology, 2,* 156-74.

Van der Doef, M.P., & Maes, S. (1998). The Job Demand-Control (-Support) Model and physical health outcomes: A review of the strain and buffer hypotheses. *Psychology and Health, 13*, 909-36.

Van der Doef, M.P., & Maes, S. (1999). The Job Demand-Control(-Support) Model and psychological well-being: A review of 20 years of empirical research. *Work & Stress, 13*, 87-114.

Dormann, C., & Zapf, D. (1999). Social support, social stressors at work, and depressive symptoms: Testing for main and moderating effects with structural equations in a three-wave longitudinal study. *Journal of Applied Psychology, 84*, 874-884.

Dormann, C., & Zapf, D. (2002). Social stressors at work, irritation, and depressive symptoms: Accounting for unmeasured third variables in a multi-wave study. *Journal of Occupational and Organizational Psychology, 75*, 33-58.

Edwards, J. R. (1998). Cybernetic theory of stress, coping and well-being. Review and extension to work and family. In C. L. Cooper (Ed.), *Theories of organizational*

stress (pp. 122-152). Oxford: Oxford University Press.

Festinger, L. (1957). *A theory of cognitive dissonance.* Evanston, IL: Row, Peterson.

Folkman, S., & Lazarus, R.S. (1980). An analysis of coping in a middle-aged community sample. *Journal of Health and Social Behavior*, *21*, 219-239.

Frese, M., & Zapf, D (1988). Methodological issues in the study of work stress: Objective vs subjective measurement of work stress and the question of longitudinal studies. In C.L. Cooper & R. Payne (Eds.), *Causes, coping and consequences of stress at work* (pp. 375-411). Chichester: John Wiley & Sons Ltd.

Frese, M. (2000). The changing nature of work. In N. Chmiel (Ed.), *Introduction to work and organizational psychology: A European perspective* (pp.424-439). Oxford, UK: Blackwell Publishers.

Ganster, D.C., & Schaubroeck, J. (1991). Work stress and employee health. *Journal of Management, 17*, 235-271.

Hacker, W. (2003). Action regulation theory: A practical tool for the design of modern work processes? *European Journal of Work and Organizational Psychology, 12*, 105-130.

Hackman, J.R. (1969). Nature of the task as a determiner of job behavior. *Personnel Psychology, 22*, 435-444.

Hackman, J. R., & Oldham, G. R. (1976). Motivation through design of work: Test of a theory. *Organizational Behavior and Human Performance, 16*, 250-79.

Hamborg, K-C, & Greif, S (2003). New technologies and stress. In J. A. M. Winnubst & C. L. Cooper (Eds.), *The handbook of work & health psychology* (pp. 209-236). Chichester: John Wiley & Sons Ltd.

Hjollund, N.H.I., Jensen, T.K., Bonde, J.P.E., Henriksen, T.B., Kolstad, H.A., Andersson, A., Ernst, E., Giwercman, A., Skakkebaek, N.E., & Olsen, J. (1998). Job strain and time to pregnancy. *Scandinavian Journal of Work, Environment and Health, 24,* 344-350.

Hobfoll, S. E. (2001). The influence of culture, community and the nested-self in the stress process: advancing Conservation of Resources theory. *Journal of Applied Psychology, 50*, 337-396.

Holman, D. J., & Wall, T. D. (2002). Work characteristics, learning-related outcomes, and strain: a test of competing direct effects, mediated, and moderated models. *Journal of Occupational Health Psychology, 7*, 283-301.

Hoogendoorn, W. E. (2001). *Work-related risk factors for low back pain*. Wageningen: Ponsen & Looijen bv.

James, L. R., & James, L. A. (1989). Causal modelling in organizational research. In C. L. Cooper, & I. T., Robertson (Eds.), *International review of industrial and organizational psychology* (pp. 371-404). New York: John Wiley & Sons Ltd.

De Jonge, J., & Kompier, M.A.J. (1997). A critical examination of the Demand-Control-Support Model from a work psychological perspective. *International Journal of Stress Management, 4*, 235-258.

De Jonge, J., Dormann, C., Janssen, P.P.M., Dollard, M.F., Landeweerd, J.A., & Nijhuis, F. J. N. (2001). Testing reciprocal relationships between job characteristics and psychological well-being: A cross-lagged structural equation model. *Journal of Occupational and Organizational Psychology, 74,* 29-46.

Karasek, R., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life.* New York: Basic Books.

Kasl, S. V. (1978). Epidemiological contributions to the study of work stress. In C. L. Cooper & R. L. Payne (Eds.), *Stress at work* (pp. 3-38). Chichester, UK: Wiley.

Kasl, S. V. (1996). The influence of the work environment on cardiovascular health: A historical, conceptual, and methodological perspective. *Journal of Occupational Health Psychology, 1,* 42-56.

Kasl, S. V., & Jones, B. A. (2003). An epidemiological perspective on research design, measurement and surveillance strategies. In J. C. Quick, & L. E. Tetrick (Eds.), *Handbook of occupational health psychology* (pp.379-398). Washington: American Psychological Association.

Kessler, R. C., & Greenberg, D. F. (1981). *Linear panel analysis. Models of quantitative change.* New York: Academic Press.

Kompier, M. A. J. (1988). *Arbeid en gezondheid van stadsbuschauffeurs* ("Work and Health of City Bus Drivers "; Ph.D Thesis). Groningen: University of Groningen. Delft: Eburon.

Kompier, M. A. J. (2002). The psychosocial work environment and health: What do we know and where should we go? *Scandinavian Journal of Work, Environment and Health*, 28, 1-4.

Kompier, M. A. J. (2003). Job design and well-being. In M. J. Schrabracq, J. A. M. Winnubst, & C. L. Cooper (Eds.), *The handbook of work & health psychology* (pp. 429-454*)*. Chichester: John Wiley & Sons Ltd.

Kompier, M , & Taris, T. (2004). Assessing methodological quality and biological plausibility in occupational health research. *Scandinavian Journal of Work, Environment and Health, 30*, 81-83.

Kristensen, T.S. (1995) The Demand-Control-Support model: Methodological challenges for future research. *Stress Medicine, 11,* 17-26.

Kristensen, T. S. (1996). Job stress and cardiovascular disease: A theoretic critical review. *Journal of Occupational Health Psychology, 1*, 246-260.

Landsbergis, P. A. (2003). The changing organization of work and the safety and health of working people: A commentary. *Journal of Occupational and Environmental Medicine, 45*, 61-72.

Le Blanc, P., de Jonge, J., & Schaufeli, W. (2000). Job stress and health. In N. Chmiel (Ed.), *Introduction to work and organizational psychology. A European perspective* (pp. 148-178). Oxford, UK: Blackwell Publishers.

Leiter, M. P., & Durup, M. J. (1996). Work, home and in-between: A longitudinal study of spillover. *Journal of Applied Behavioral Science, 32*, 29-47.

Michie, S., & Williams, S. (2003). Reducing work related psychological ill health and sickness absence: a systematic literature review. *Occupational and Environmental Medicine, 60*, 3-9.

Meijman T.F, & Mulder, G. (1998). Psychological aspects of workload. In P. J. D. Drenth, H. K. Thierry, Ch. J. De Wolff (Eds.), *Handbook of work and organizational psychology* (2nd Edn, pp. 5-33). Hove: Psychology Press.

Nesselroade, J. R., & Baltes, P. B. (Eds., 1979). *Longitudinal research in the study of behavior and development*. New York: Academic Press.

Perrewé, P. L., & Ganster, G. (1989). The impact of job demands and behavioral control on experienced job stress. *Journal of Organizational Behavior, 10*, 213-229.

Rogosa, D. (1980). A critique of cross-lagged correlation. *Psychological Bulletin, 88*, 245-258.

Rothman, K. J., & Greenland, S. (1998). *Modern Epidemiology*. Philadelphia: Lippincott-Raven publishers.

Semmer, N., Zapf, D., & Greif, S. (1996). "Shared job strain": A new approach for assessing the validity of job stress measurements. *Journal of Occupational and Organizational Psychology, 69*, 293-310.

Semmer, N., Grebner, S, & Elfering, A. (2004). Beyond self-report: Using observational, physiological, and situation-based measures in research on occupational stress. In P. L. Perrewé and D. C. Ganster (Eds.), *Research in occupational stress and well-being* (vol. 3, pp. 205-263). New York: Elsevier.

Siegrist, J. (1998). Adverse health effects of effort-reward imbalance at work. In C. L. Cooper (Ed.), *Theories of Organizational Stress* (pp. 52-66). New York: Oxford University Press.

Sluijter, J. K., Frings-Dresen, M. H. W., van der Beek, A. J., & Meijman, T. F. (2001). The relation between work-induced neuroendocrine reactivity and recovery, subjective need for recovery, and health status. *Journal of Psychosomatic Research, 50*, 29-37.

Spector, P.E. (1992). A consideration of the validity and meaning of self-report measures of job conditions. *International Review of Industrial and Organizational Psychology,*

7, 123-151.

Spector, P.E. (1999). Objective versus subjective approaches to the study of job stress. *Journal of Organizational Behavior, 20*, 737-738.

Steenland, K., Johnson, J., & Nowlin, S. (1997). A follow-up study of job strain and heart disease among males in the NHANES1 population. *American Journal of Industrial Medicine, 31,* 256-260.

Taris, T.W., Bok, I.A., & Caljé, D.G. (1998). On the relation between job characteristics and depression: A longitudinal study. *International Journal of Stress Management, 5*, 157-167.

Taris, T.W., & Feij, J.A. (2005). Learning and strain among newcomers: A three-wave study on the effects of job demands and job control. *Journal of Psychology*. *138*, 543-563.

Taris, T.W., Kompier, M.A.J., de Lange, A.H., Schaufeli, W.B., & Schreurs, P.J.G. (2003). Learning new behaviour patterns: A longitudinal test of Karasek's active learning hypothesis among Dutch teachers. *Work & Stress*, *17*, 1-20.

Taris, T. W., & Kompier, M.A.J. (2003). Challenges in longitudinal designs in occupational health psychology. *Scandinavian Journal of Work, Environment and Health, 29*, 1-4.

Taris, T. W., & Kompier, M. A. J. (2004). Job characteristics and learning behavior. In P. L. Perrewé & D. C. Ganster (Eds.), *Research in Occupational Stress and Well-being: Exploring interpersonal dynamics*, vol. 4. (pp. 127-166). Amsterdam: JAI Press.

Tennant, C. (2001). Work-related stress and depressive disorders. *Journal of Psychosomatic Research, 51*, 697-704.

Theorell, T., & Karasek, R. A. (1996). Current issues relating to psychosocial job strain and cardiovascular disease research. *Journal of Occupational Health Psychology, 1,* 9-26.

Van der Klink, J. J.L., Blonk, R. W. B., Schene, A. H., & Van Dijk, F. J. H. (2001). The benefits of interventions for work-related stress. *American Journal of Public Health*, *91*, 270-6.

Waldenström, K., Lundberg, I., Waldenström, M., Härenstam, Moa Research Group (2002). Does psychological distress influence reporting of demands and control at work? *Occupational and Environmental Medicine, 60*, 887-891.

Zapf, D., Dormann, C., & Frese, M. (1996). Longitudinal studies in organizational stress research: A review of the literature with reference to methodological issues. *Journal of Occupational Health Psychology, 1,* 145-169

Summary

Introduction

Mental health problems constitute one of the three leading causes of work disability worldwide and have negative consequences for the individual as well as the companies they work for. The Netherlands reports one of the highest and also growing percentages (38%) of work incapacitation due to mental health disorders. In 2003 the annual costs for sickness absence duration and work disability due to mental health problems has been estimated at €3 billion. Against the background of this growing problem, this thesis examined whether job characteristics may be regarded as causes of mental health problems or vice versa.

We used the strain hypothesis of the Demand-Control-(Support; DC/S) model to examine the cross-lagged relations between the psychosocial work characteristics and mental health in more detail. According to this strain hypothesis mental health problems can be expected in a job with high job demands and low job control (and low social support). Although the DC/S model has been examined in numerous studies, our understanding of the possible causal linkage between the DC/S dimensions and mental health remained limited, due to several unresolved issues of the earlier (mostly cross-sectional) research.

In Chapter 1 of this thesis, we distinguished five unresolved issues of earlier research. We did not know: i) whether earlier high-quality longitudinal research found consistent cross-lagged relations between the DC/S dimensions and mental health, ii) which type(s) of causal relation(s) existed between the DC/S dimensions and mental health (normal, reversed or reciprocal?), iii) which time lag(s) (were) best suited for examining the cross-lagged relations between the DC/S dimensions and mental health, iv) whether duration of exposure could account for normal cross-lagged relations, and v) which mechanism(s) could account for possible reversed lagged relations. We addressed these issues by a) systematically reviewing the methodologically best longitudinal studies examining the DC/S model, b) examining the relation between work and mental health within the framework of a prospective Dutch 4-wave cohort study on musculoskeletal disorders, absenteeism, stress and health (SMASH), and c) elaborating on the possible mechanisms that may account for normal as well as reversed cross-lagged relations. These unresolved

issues were dealt with in Chapters 2-6, and the main results presented are summarized below.

Results

Unresolved issue 1: What are the results of (high-quality) longitudinal research? Chapter 2 presents the results of a systematic review of 45 longitudinal studies examining the DC/S model. The application of five important methodological criteria (adequate study design, presence of an argumentation for the time lag used, good quality measures, adequate method of analysis, and presence of a nonresponse analysis, respectively) showed that only 19 (42 %) of these could be regarded as methodologically *high-quality* studies. The review of these 19 high-quality studies revealed only modest support for the strain hypothesis of the DC/S model. However, 16 of these studies did provide support for normal separate cross-lagged effects of the DC/S dimensions; only two of these high-quality studies controlled for reversed or reciprocal causation.

Unresolved issue 2: Three types of causation in the relation between work and mental health? In Chapter 3 we examined, within the 4-wave SMASH study, how the associations between the DCS dimensions and mental health should best be conceptualised: as normal, reversed or as reciprocal cross-lagged relations. We postulated and compared the fit of different structural equation models reflecting the different types of causation, and found consistent evidence for reciprocal cross-lagged relations between the DCS dimensions and indicators of mental health. We also revealed that the normal cross-lagged effects were causally predominant.

Unresolved issue 3: Which length of time lag(s) is (are) correct? The 4-wave SMASH study gave us the opportunity to examine three different lengths of time lags and combinations of these, namely 1-, 2-, and 3-year time lags. Chapter 3 showed that 1-year time lags yielded the best effects for the reciprocal cross-lagged relation between the DCS dimensions and mental health.

Unresolved issue 4: Can exposure history account for normal cross-lagged effects? In Chapter 4, we developed a classification of theoretically meaningful Demand-Control histories (DCH's or "exposure profiles") and formulated hypotheses concerning their across-time development in terms of (mental) health outcomes. In line with our

expectations, the highest levels of mental health problems were found for incumbents of stable high strain jobs, whereas relatively few mental health problems were reported by employees working in stable low strain jobs across time. Further, the employees in the stable strain jobs (with high demands and low control) reported significant increases in mental health problems. However, mixed results were found for the changing DCH's. The results showed that changes from Time 1 low strain to later high strain work, and from Time 1 active/passive work to later high strain work were indeed associated with elevated levels of mental health complaints. Nevertheless, the positive change from a high strain to a no-high strain job was not significant for the mental health indicators.

Chapter 4 also revealed significant associations between changes in DCH's (i.e., changes in self-reported demands and control) and self-reported job changes. Moreover, the employees who reported negative changes in self-reported job conditions were more likely to have experienced this change as stressful, compared to workers with positive DCH's. Consequently, these results revealed that changes in subjectively experienced well-being can be traced back to corresponding changes in the work environment.

Unresolved issue 5: Which mechanisms account for reversed cross-lagged effects? In Chapter 5 we proposed and tested four mechanisms for possible reversed mental health that reflect perceptual versus environmental changes: (i) rosy perception mechanism, (ii) gloomy perception mechanism, (iii) upward selection mechanism, and (iv) drift mechanism. Chapter 5 revealed results in line with the rosy perception mechanism (positive reversed effect from mental health on job demands), the upward selection mechanism (positive reversed effect from mental health on job control), and the gloomy perception mechanism (negative reversed effect from mental health on supervisor social support).

Implications and recommendations

Chapter 6 describes the (methodological) limitations, assets, theoretical as well as practical implications, and recommendations of the aforementioned results. We can conclude from this thesis that the relation between the DCS dimensions and mental health is more dynamic than most workstress models convey. Furthermore, different normal and reversed causation mechanisms can account for the reciprocal nature of the relation between work and mental health. More specifically, the main theoretical implications and recommendations of this thesis can be summarized as:

i) The few high-quality studies presented in Chapter 2 revealed that researchers should pay more attention to quality aspects in designing their studies;

ii) The support for separate main effects (instead of support for the strain hypothesis) of the DC/S dimensions in Chapter 2 revealed that future research should focus more on these separate main effects of the DC/S dimensions, instead of focusing on their multiplicative interaction or combined effects;

iii) The presented evidence for reciprocal causal relations between the DCS dimensions and mental health revealed that (besides the normal cross-lagged relations) more theorizing and research should be conducted on reversed or reciprocal causation in the relation between work and mental health;

iv) The best fit for 1-year time lags revealed that more research should be conducted on the effects of different time lags (e.g., smaller than 1-year time lags) in the relation between work and mental health. In determining the length of time lag(s) researchers should consider: a) the type of predictor(s) and outcome(s) being measured, b) (the shape of) the intra- and inter-group across-time development of the relation between the predictor and outcome, c) the onset, amount, and duration of exposure to the stressors of interest, d) the (preexisting) vulnerability of the selected population (in terms of mental and physical complaints), and e) other relevant confounders in relation between work and mental health. When possible, researchers should design complete panel studies with many follow-up measures that are both evenly and unevenly spaced;

v) The evidence for different environmental as well as perceptual reversed causation mechanisms revealed that more environment-based as well as cognitive psychological theory and research are needed to further understand the reversed mental health effects.

Chapter 6 concludes with the practical implications of this thesis. The normal cross-lagged effects found in this thesis illustrated that work related interventions directed at decreasing job demands, increasing job control and/or supervisor social support may indeed improve the mental health of workers. We especially recommend these job (re-)design interventions for ('high-risk') subgroups of workers who work in a high strain job (with high job demands, low job control) for a prolonged period of time, and for workers who

transfer to a high strain job. Professionals working in the occupational health field should also consider the potential feedback loop of mental health. Person-directed interventions may be needed for more vulnerable workers to retain and improve their mental health status.

Samenvatting

Inleiding

Psychische aandoeningen vormen één van de drie belangrijkste oorzaken voor arbeidsongeschiktheid over de gehele wereld. Nederland rapporteert zelfs één van de hoogste en tevens groeiende percentages (38%) arbeidsongeschiktheid als gevolg van psychische aandoeningen. De kosten van verzuim en WAO-intrede door deze psychische klachten bedroegen in 2003 ongeveer 1% van het bruto binnenlands product (ruim €3 miljard). Psychische klachten hebben dus niet alleen negatieve gevolgen voor de werknemer zelf, maar ook voor de betrokken werkgever en organisatie. Gezien deze groeiende problematiek heeft dit proefschrift als doel de relatie tussen psychosociale werkkenmerken en psychische klachten nader te onderzoeken. De vraag die aan de orde wordt gesteld, is hoe deze relatie het best geconceptualiseerd kan worden. Kunnen werkkenmerken als oorzaak beschouwd worden van mentale gezondheid, of is de relatie vice versa?

Om deze vraag nader te onderzoeken, is gebruik gemaakt van de spanningshypothese van het Demand-Control-(Support; DC/S) model. Deze hypothese veronderstelt dat een combinatie van hoge taakeisen en weinig sturingsmogelijkheden (en weinig sociale steun) leidt tot stressreacties (zoals verminderde arbeidssatisfactie, verhoogde depressie en verhoogde bloeddruk). Hoewel er al veel studies en reviews naar dit werkstress model verschenen zijn, is het nog niet duidelijk hoe de relatie tussen werk en mentale gezondheid in causale termen geconceptualiseerd moet worden. Na literatuuronderzoek (zie hoofdstukken 1 en 2) werd namelijk duidelijk dat het tot nu toe beschikbare (voornamelijk cross-sectionele) onderzoek een aantal (methodologische) tekortkomingen of onopgeloste vragen kent. Uit het al beschikbare onderzoek werd nog niet duidelijk: i) of eerder hoogwaardig longitudinaal vragenlijstonderzoek consistente longitudinale relaties heeft gevonden tussen de DC/S dimensies en mentale gezondheid, ii) welke type(n) causale relatie(s) bestaan tussen de DC/S dimensies en mentale gezondheid (normale, tegengestelde of reciproque, dat wil zeggen wederkerige relaties?), iii) welke tijdsinterval(len) geschikt

zijn voor longitudinaal onderzoek naar de relatie tussen de DC/S dimensies en mentale gezondheid, iv) of de expositie/ blootstellingsduur aan de psychosociale werkkenmerken de normale causale longitudinale relaties kan verklaren en v) welke mechanisme(n) mogelijk tegengestelde longitudinale relaties kunnen verklaren. Deze onopgeloste vragen hebben wij geprobeerd te beantwoorden door middel van: a) een systematische review van methodologisch hoogwaardig longitudinaal vragenlijstonderzoek naar het DC/S model, b) empirisch onderzoek gebaseerd op een Nederlandse (driejarige) prospectieve cohort studie onder 1789 werknemers werkzaam in 34 verschillende bedrijven (SMASH: Study on Musculoskeletal disorders, Absenteeism, Stress and Health; verzameld door TNO Arbeid), en c) het uitwerken en testen van mogelijke mechanismen die normale en tegengestelde causale relaties kunnen verklaren. Deze onopgeloste vragen zijn verder uitgewerkt in hoofdstuk 2-6. Hieronder volgt een korte samenvatting van de belangrijkste resultaten uit dit proefschrift.

Resultaten

Onopgeloste vraag 1: Wat zijn de resultaten uit eerder hoogwaardig longitudinaal vragenlijstonderzoek? Hoofdstuk 2 geeft de resultaten weer van een systematische review van 45 longitudinale onderzoeken naar het DC/S model. Na de toepassing van vijf methodologische criteria (te weten: adequaat onderzoeksmodel, argumentatie voor gebruikte tijdsintervallen, goede kwaliteit meetinstrumenten, adequate analysetechniek, en onderzoek naar selectiviteit van responsegroep), blijken slechts 19 van deze 45 studies (42%) bestempeld te kunnen worden als hoogwaardig longitudinaal onderzoek. De 19 hoogwaardige studies geven weinig ondersteuning voor de spanningshypothese van het DC/S model weer. Zestien hoogwaardige studies rapporteren echter wel consistente normale causale relaties tussen één of meer van de DC/S dimensies en (mentale) gezondheidsuitkomsten. Er werd dus wel evidentie gevonden voor consistente longitudinale (normale causale) relaties tussen de DC/S dimensies en mentale gezondheid. Twee hoogwaardige studies controleerden op tegengestelde of reciproque causale relaties en vonden hiervoor geen evidentie.

Onopgeloste vraag 2: Drie typen causaliteit in de relatie tussen werk en mentale gezondheid? In hoofdstuk 3 werd onderzoek gedaan naar welke type(n) causale relatie(s)

(normale, tegengestelde of reciproque) bestaan tussen de DCS dimensies en mentale gezondheid. Verschillende structurele vergelijkingsmodellen met normale, tegengestelde of reciproque causale relaties werden vergeleken. De beste model fit werd gevonden voor reciproque causale relaties tussen de DCS dimensies en indicatoren van mentale gezondheid. Dit wil zeggen dat er wederkerige relaties werden gevonden tussen de werkkenmerken en indicatoren van mentale gezondheid. De DCS dimensies gemeten op tijdstip 1 bleken de mentale gezondheidsklachten op een later tijdstip te voorspellen, terwijl de mentale gezondheid op tijdstip 1 ook van invloed bleek te zijn op de gerapporteerde DCS dimensies op een later tijdstip. In deze reciproque of wederkerige relaties bleken de normale causale effecten van de DCS dimensies op mentale gezondheid dominant te zijn.

Onopgeloste vraag 3: Wat is de correcte tijdsinterval(len) voor de relatie tussen werk en mentale gezondheid? De vier metingen van de SMASH studie gaven ons de mogelijkheid om drie verschillende lengtes van tijdsintervallen en combinaties hiervan nader te onderzoeken. Uit hoofdstuk 3 blijkt dat de 1-jarige tijdsintervallen (1994-1995, 1995-1996, 1996-1997) de beste resultaten weergeven voor de reciproque longitudinale relatie tussen de DCS dimensies en mentale gezondheid.

Onopgeloste vraag 4: Kan de duur in blootstelling aan de werkkenmerken de normale causale relaties verklaren? In hoofdstuk 4 is een indeling gemaakt in theoretisch betekenisvolle Demand-Control profielen (of 'DC histories', 'DCH's' of 'exposure profiles'). Deze profielen geven weer of de werknemers, gedurende de 4 metingen van de studie, in stabiele of veranderende banen hebben gewerkt. Vervolgens zijn, in overeenstemming met de spanningshypothese, meer specifieke hypothesen geformuleerd voor de stabiele en veranderende DCH's. Er werd bevestiging gevonden voor de spanningshypothese in de stabiele DCH's. Significante verbanden werden namelijk gevonden tussen subjectief ervaren welzijn en veranderingen in de werkomgeving. De meeste spanningsklachten werden gerapporteerd door werknemers werkzaam in stabiele hoge spanningsbanen (met hoge taakeisen en lage sturingsmogelijkheden), terwijl relatief weinig spanningsklachten gerapporteerd werden door werknemers werkzaam in lage spanningsbanen (met lage taakeisen en lage sturingsmogelijkheden). De werknemers in de stabiele hoge spanningsbanen bleken verder significante toenames in spanningsklachten (depressie en arbeidssatisfactie) over de tijd weer te geven. De resultaten voor de

veranderende DCH's waren minder eenduidig. De veranderende DCH's van tijdstip 1 actieve/passieve of lage spanningsbanen naar een latere hoge spanningsbaan gaven significante toenames in hun spanningsklachten weer, maar de veranderende DCH's van tijdstip 1 hoge spanningsbaan naar latere actieve/passieve of lage spanningsbanen lieten geen significante afname in spanningsklachten zien.

In hoofdstuk 4 werden ook significante verbanden gevonden tussen veranderingen in gerapporteerde psychosociale werkkenmerken en feitelijke baanveranderingen. De werknemers die negatieve veranderingen in zelfgerapporteerde werkkenmerken weergaven (negatieve DCH's), vonden de feitelijke baanveranderingen die zij hadden ondergaan ook meer stresserend (in vergelijking tot de positieve DCH's).

Onopgeloste vraag 5: Welke mechanismen kunnen tegengestelde causale relaties verklaren? In hoofdstuk 5 zijn vier mogelijke mechanismen voor tegengestelde causale effecten van mentale gezondheid op werk uitgewerkt, namelijk: (i) rooskleurig perceptie-mechanisme, (ii) somber perceptie-mechanisme, (iii) opwaarts selectie-mechanisme, en (iv) neerwaarts (of'drift') selectie-mechanisme. Deze mechanismen zijn gebaseerd op perceptie- of omgevingseffecten. De resultaten uit hoofdstuk 5 zijn in overeenstemming met drie van deze 'tegengestelde causaliteit' mechanismen, namelijk: het rooskleurig perceptie-mechanisme (positief tegengesteld effect van mentale gezondheid op taakeisen), het opwaarts selectie-mechanisme (positief tegengesteld effect van mentale gezondheid op sturingsmogelijkheden), en het somber perceptie-mechanisme (negatief tegengesteld effect van mentale gezondheid op sociale steun van de supervisor).

Implicaties en aanbevelingen

In hoofdstuk 6 wordt aandacht besteed aan de (methodologische) sterktes en tekortkomingen, aan theoretische en praktische implicaties van de gevonden resultaten en aan aanbevelingen voor toekomstig onderzoek. Op basis van dit proefschrift kan geconcludeerd worden dat de longitudinale relaties tussen de DC/S dimensies en mentale gezondheid meer dynamisch zijn dan de meeste werkstressmodellen doen geloven. Verder blijken verschillende mechanismen een rol te spelen in het verklaren van deze reciproque relatie tussen psychosociale werkkenmerken en mentale gezondheid.

De theoretische implicaties en aanbevelingen van deze resultaten kunnen als volgt samengevat worden:

Het beperkte aantal hoogwaardig longitudinale vragenlijstonderzoeken naar het DC/S model leidt ertoe dat toekomstig longitudinaal onderzoek methodologisch beter ontworpen dient te worden. Onderzoekers moeten meer tijd besteden aan de methodologische kwaliteit van hun studies;

De beperkte evidentie voor de spanningshypothese van het DC/S model (zie hoofdstuk 2) geeft weer dat toekomstig onderzoek zich beter kan richten op de afzonderlijke hoofdeffecten (in plaats van de statistische interactie effecten) van de psychosociale werkkenmerken in het voorspellen van mentale gezondheid;

De gevonden reciproque of wederkerige causale relatie tussen de DCS dimensies en mentale gezondheid impliceert dat er meer theorie ontwikkeld en onderzoek verricht moet worden naar tegengestelde of reciproque causaliteit;

De resultaten voor 1-jarige tijdsintervallen leiden tot de aanbeveling meer onderzoeken te verrichten naar de effecten van verschillende tijdsintervallen (onder andere kleiner dan 1-jarige tijdsintervallen) in de longitudinale relatie tussen werk en mentale gezondheid. Verder blijkt uit dit proefschrift dat onderzoekers de keuze van hun tijdsinterval beter theoretisch en methodologisch moeten onderbouwen. Een onderzoeker dient met de volgende factoren rekening te houden bij de keuze van een tijdsinterval: a) de specifieke predictor(en) en uitkomst(en) die gemeten worden, b) verschillen tussen en binnen groepen met betrekking tot hoe de relatie tussen werk en mentale gezondheid ontwikkeld over de tijd, c) de voorgeschiedenis (begin, duur en mate) in blootstelling aan de stressoren die men wil onderzoeken, d) de (voorgeschiedenis in) mentale en fysieke kwetsbaarheid van de geselecteerde steekproef, en e) andere relevante covariaten in de relatie tussen werk en mentale gezondheid. Onderzoekers moeten, zo mogelijk, een compleet panel design opzetten met meerdere follow-up metingen die gelijk en ongelijk afgenomen worden in de tijd (gebaseerd dus op variaties in tijdsintervallen);

Er is meer omgevingsgerichte en cognitief psychologische theorie en onderzoek nodig om de tegengestelde causale relaties tussen mentale gezondheid en werk beter te begrijpen.

Hoofdstuk 6 eindigt met de bespreking van de praktische implicaties van dit proefschrift. De normale causale effecten van werk op gezondheid (in Hoofdstuk 3) geven weer dat werkgerelateerde interventies gericht op het reduceren van taakeisen en verhogen van sturingsmogelijkheden en/of sociale steun van supervisoren, de mentale gezondheid van werknemers over de tijd daadwerkelijk kunnen verbeteren. Deze werk (her-)ontwerp interventies zijn met name nodig voor zogenaamde hoge risico groepen. Dit zijn werknemers die over langere periodes werkzaam zijn in hoge spanningsbanen (met hoge taakeisen en lage sturingsmogelijkheden (en sociale steun van supervisoren) en werknemers die net in een hoge spanningsbaan zijn gaan werken. Arbeid- en gezondheidsdeskundigen en werkgevers moeten bovendien rekening houden met mogelijke tegengestelde effecten van mentale gezondheid op psychosociale werkkenmerken. Persoonsgerichte interventies kunnen voor hoge risico groepen nodig zijn om de mentale gezondheid te behouden of te verbeteren.

About the Author

Annet de Lange was born in Zwolle (the Netherlands) on 2 April 1977. In 1995 she received her diploma from the Heertganck grammar school in Heerde and started her psychology studies at the University of Utrecht. In 1999 she obtained her Master of Science degree in Psychology of Work, Organisation and Health. In November 1999 she started her PhD-research at the Department of Work and Organisational Psychology at the Radboud University Nijmegen. During her PhD-work she was active in several PhD-committees (SWAIOO, Rutten-Instituut, PhD-member of Kurt Lewin Institute) and was secretary of the Dutch Working group of Occupational Health Researchers (WAOP).

In 2002 her work was rewarded with the Dr. IBM Frye stipendium. She used this stipendium to visit Dr. Paul Landsbergis, Dr. Joe Schwartz and Dr. Peter Schnall at the Mount Sinai Medical School in New York. September 2003 she started working as an assistant professor human resource management/ organisational behaviour at the Department of Business Administration of the Vrije Universiteit of Amsterdam. She teaches bachelor and master students (organisational behaviour and business research methods), and continues to examine the longitudinal relationship between work and (mental) health.

Her most recent work has been rewarded with the "Andre Büssing Memorial Award" of the European academy of occupational health research (www.ea-ohp.org). More information about her work can be found on: http://staff.feweb.vu.nl/alange.

The "Kurt Lewin Institute Dissertation Series" started in 1997. Since 2003 the following dissertations have been published:

2003-1: Femke Bennenbroek: *Social comparison and coping with radiation therapy. The significance of different dimensions of comparis*on

2003-2: Marlene Roefs: *Public Participation and Perceived (in)justice in South Africa, 1995-2000*

2003-3: Rick van Baaren: *Mimicry: A social perspective*

2003-4: Michaéla Schippers: *Reflexivity in teams*

2003-5: Heleen van Mierlo: *Self-managing teamwork and psychological well-being*

2003-6: Ruben Taris: *Person-Environment Fit: A longitudinal study of the interaction between employees characteristics and work environmental characteristics*

2003-7: Rob Holland: *On the structure and consequences of attitude strength*

2003-8: Camiel Beukeboom: *How mood turns on language*

2003-9: Joost Miedema: *Fairness and the Self*

2004-1: Wolfgang Steinel: *Misleading in social decision-making: A motivational approach*

2004-2: Edwin van Hooft: *Job seeking as planned behavior. In search of group differences*

2004-3: Kirsten Ruys: *The influence of self and similarity on immediate affective impressions of people*

2004-4: Michel Handgraaf: *Self-interest and other-oriented motives in social decision making: An ultimatum bargaining perspective*

2004-5: Sjoerd Goslinga: *Betrokkenheid, participatie en ledenverloop in vakbonden*

2004-6: Nynke Frieswijk: *Frail, but happy: The importance of self-management ability and social comparison among elderly persons*

2004-7: Jaap Ham: *Bridging attribution and spontaneous inferences: Spontaneou sandintentional components of dispositional and situational inferences*

2004-8: Mirjam Tazelaar: *When things go wrong: The influence of noise on interactions*

2004-9: Marjolein de Best-Waldhober: *Coördinatie in interdependente situaties: Over de afweging van directe uitkomsten versus uitkomsten op lange termijn*

2004-10: Hinke Groothof: *When others are doing better or worse: Responses from the heart and the head*

2004-11: Laetitia Mulder: *Throwing light on the dark side of sanctions. Sanctioning systems in social dilemmas re-examined*

2004-12: Annebel de Hoogh: *Personality and charismatic leadership: A matter of context*

2004-13: Brigitte ten Brink: *Psychological contract: A useful concept?*

2004-14: Gerben van Kleef: *Emotion in social conflict. The interpersonal effects of emotions in negotiations*

2004-15: Tom Frijns: *Keeping secrets: Quantity, quality and consequences*

2005-1: Elsbeth Steenland: *Stereotype Change: Effects of disconfirming information*

2005-2: Annet de Lange: *What about causality? Examining longitudinal relations between work characteristics and mental health*